



US005600672A

United States Patent [19]

Oshima et al.

[11] Patent Number: 5,600,672
[45] Date of Patent: Feb. 4, 1997

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09/677421



10/05/00

[54] COMMUNICATION SYSTEM

[75] Inventors: Mitsuaki Oshima, Kyoto; Seiji Sakashita, Osaka, both of Japan

[73] Assignee: Matsushita Electric Industrial Co., Ltd., Osaka, Japan

[21] Appl. No.: 240,521

[22] Filed: May 10, 1994

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 857,627, Mar. 25, 1992.

[30] Foreign Application Priority Data

Mar. 27, 1991	[JP]	Japan	3-62798
Apr. 25, 1991	[JP]	Japan	3-95813
May 29, 1991	[JP]	Japan	3-155650
Jul. 23, 1991	[JP]	Japan	3-182236
Mar. 17, 1992	[JP]	Japan	4-60739
May 10, 1993	[JP]	Japan	5-132984
Sep. 24, 1993	[JP]	Japan	5-261612
Dec. 27, 1993	[JP]	Japan	5-349972
Mar. 24, 1994	[JP]	Japan	6-79668

[51] Int. Cl.⁶ H04L 5/16; H04B 1/38

[52] U.S. Cl. 375/219; 375/270; 375/301; 375/321

[58] Field of Search 375/219, 259, 375/260, 261, 262, 265, 270, 240, 321, 326, 341, 354; 348/725, 726, 723, 724

[56] References Cited

U.S. PATENT DOCUMENTS

5,164,963 11/1992 Lawrence et al. 375/265

OTHER PUBLICATIONS

Shanmugam, "Digital and Analog Communication Systems" 1979, p. 272.

Primary Examiner—Stephen Chin

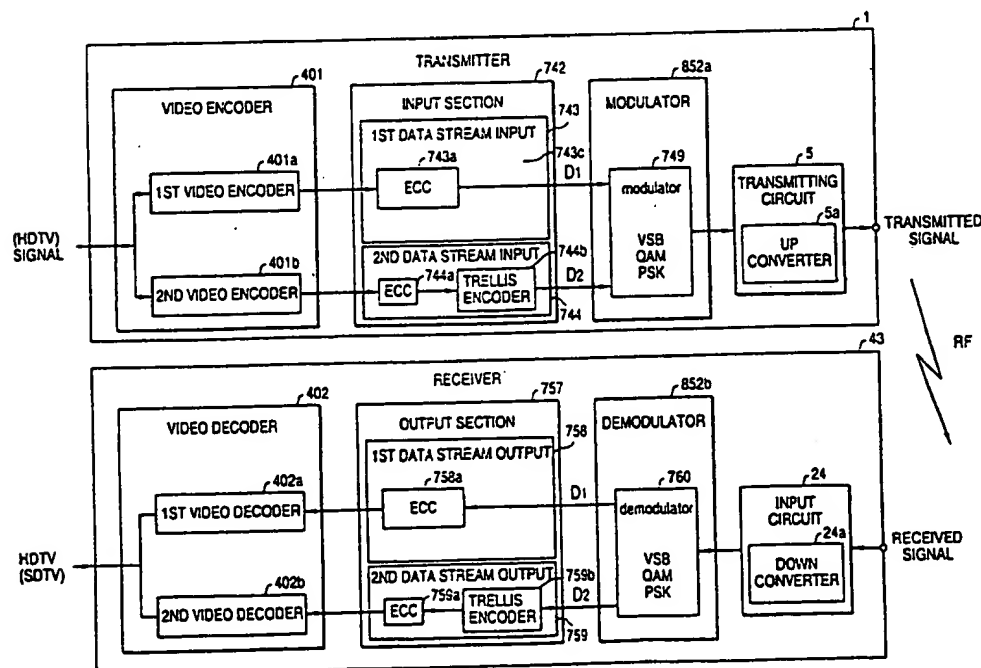
Assistant Examiner—Hai H. Phan

Attorney, Agent, or Firm—Wenderoth, Lind & Ponack

[57] ABSTRACT

At the transmitter side, carrier waves are modulated according to an input signal for producing relevant signal points in a signal space diagram. The input signal is divided into, two, first and second, data streams. The signal points are divided into signal point groups to which data of the first data stream are assigned. Also, data of the second data stream are assigned to the signal points of each signal point group. A difference in the transmission error rate between first and second data streams is developed by shifting the signal points to other positions in the space diagram expressed at least in the polar coordinate system. At the receiver side, the first and/or second data streams can be reconstructed from a received signal. In TV broadcast service, a TV signal is divided by a transmitter into low and high frequency band components which are designated as first and second data streams respectively. Upon receiving the TV signal, a receiver can reproduce only the low frequency band component or both the low and high frequency band components, depending on its capability. Furthermore, a communication system based on an OFDM system is utilized for data transmission of a plurality of subchannels, wherein the subchannels are differentiated by changing the length of a guard time slot or a carrier wave interval of a symbol transmission time slot, or changing the transmission electric power of the carrier.

12 Claims, 178 Drawing Sheets



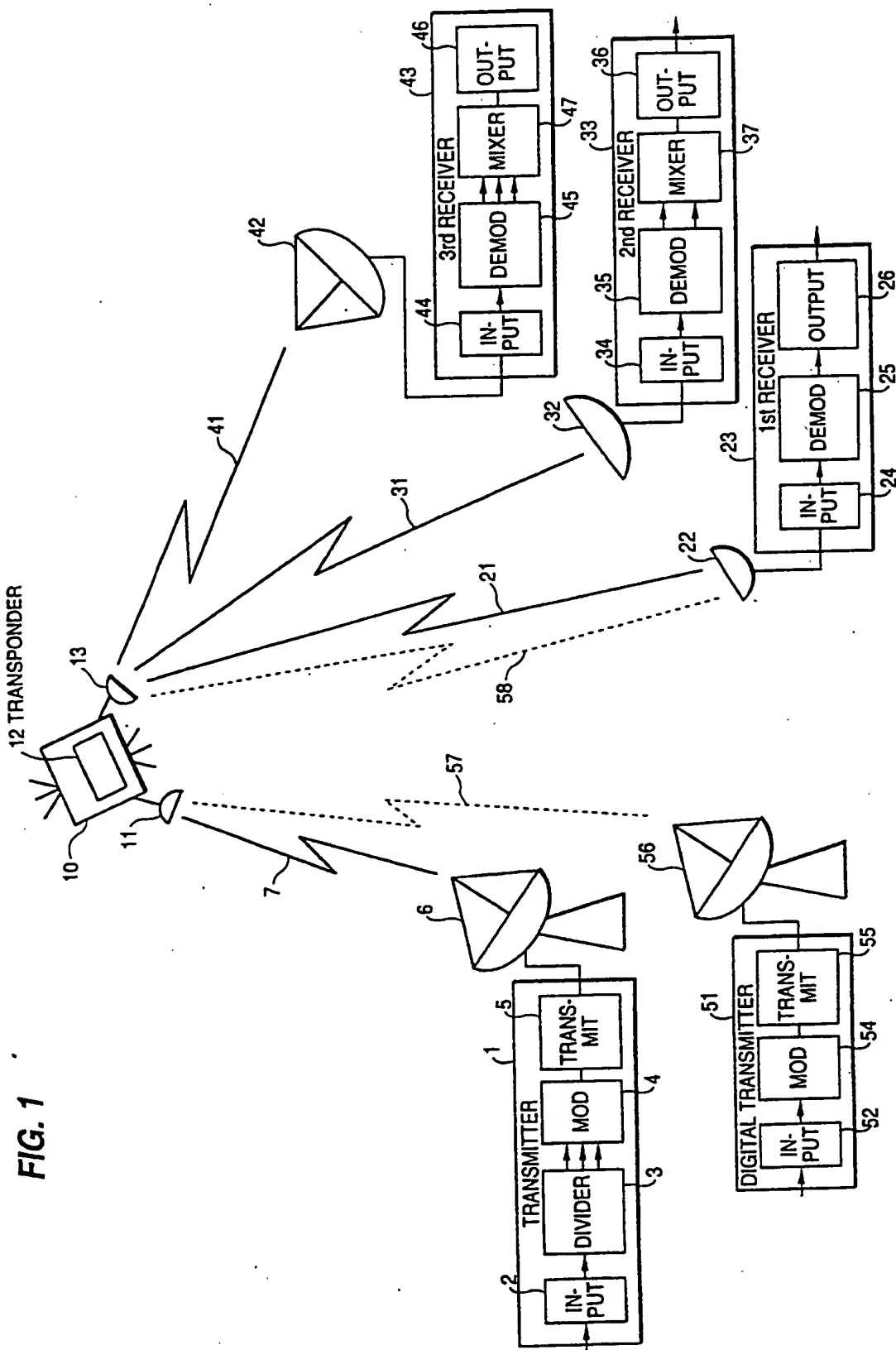


FIG. 2

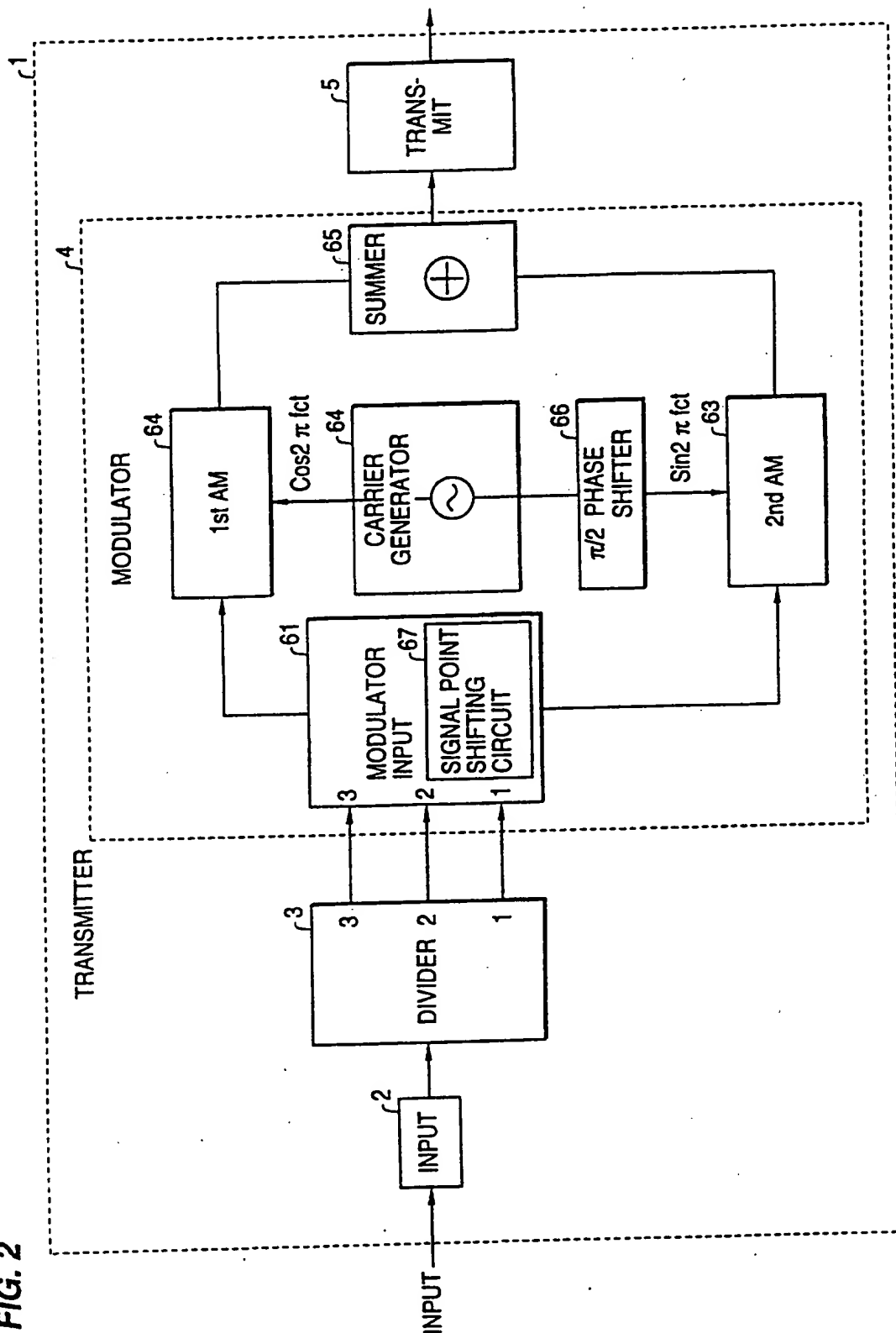


FIG. 3

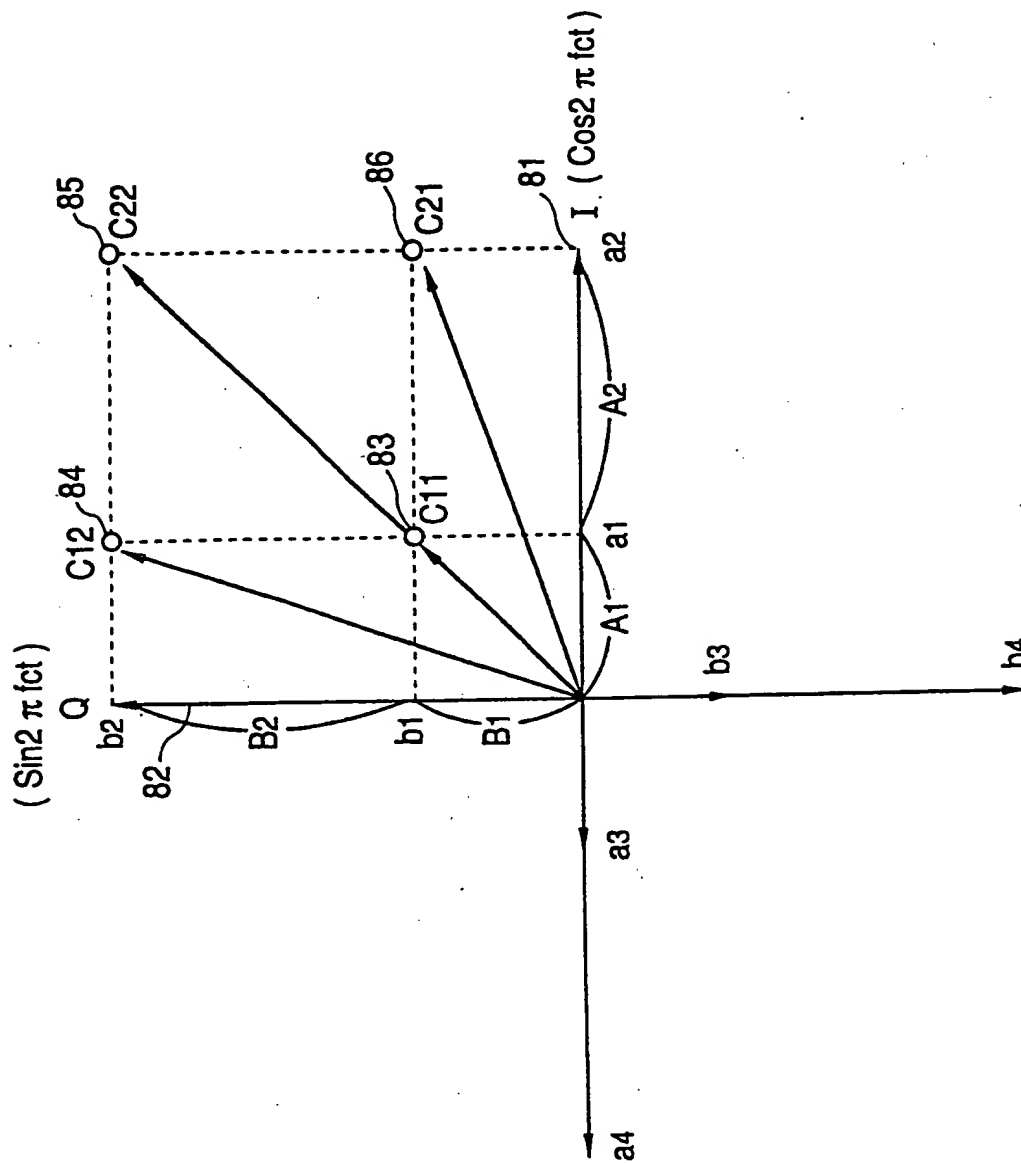


FIG. 4

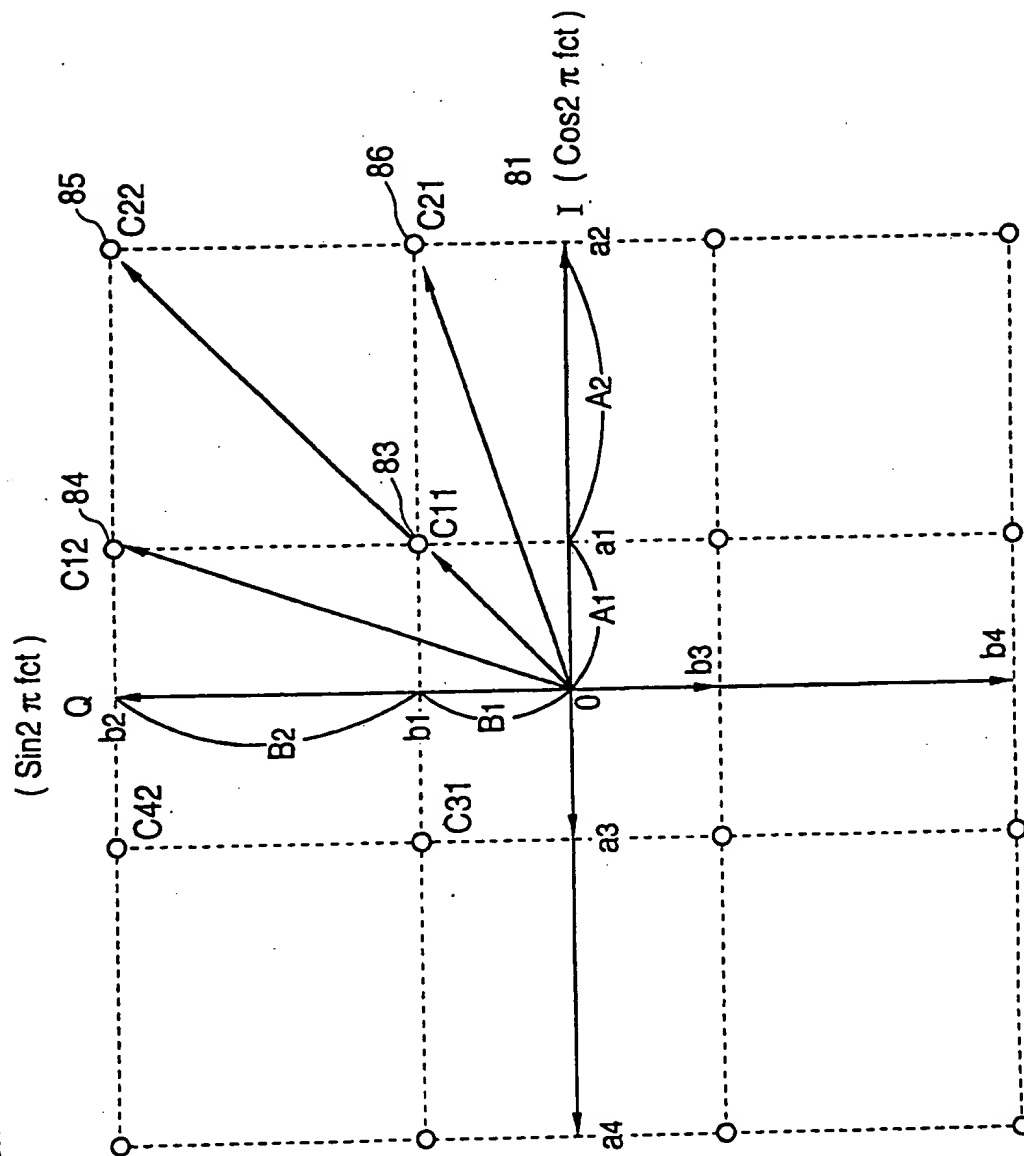
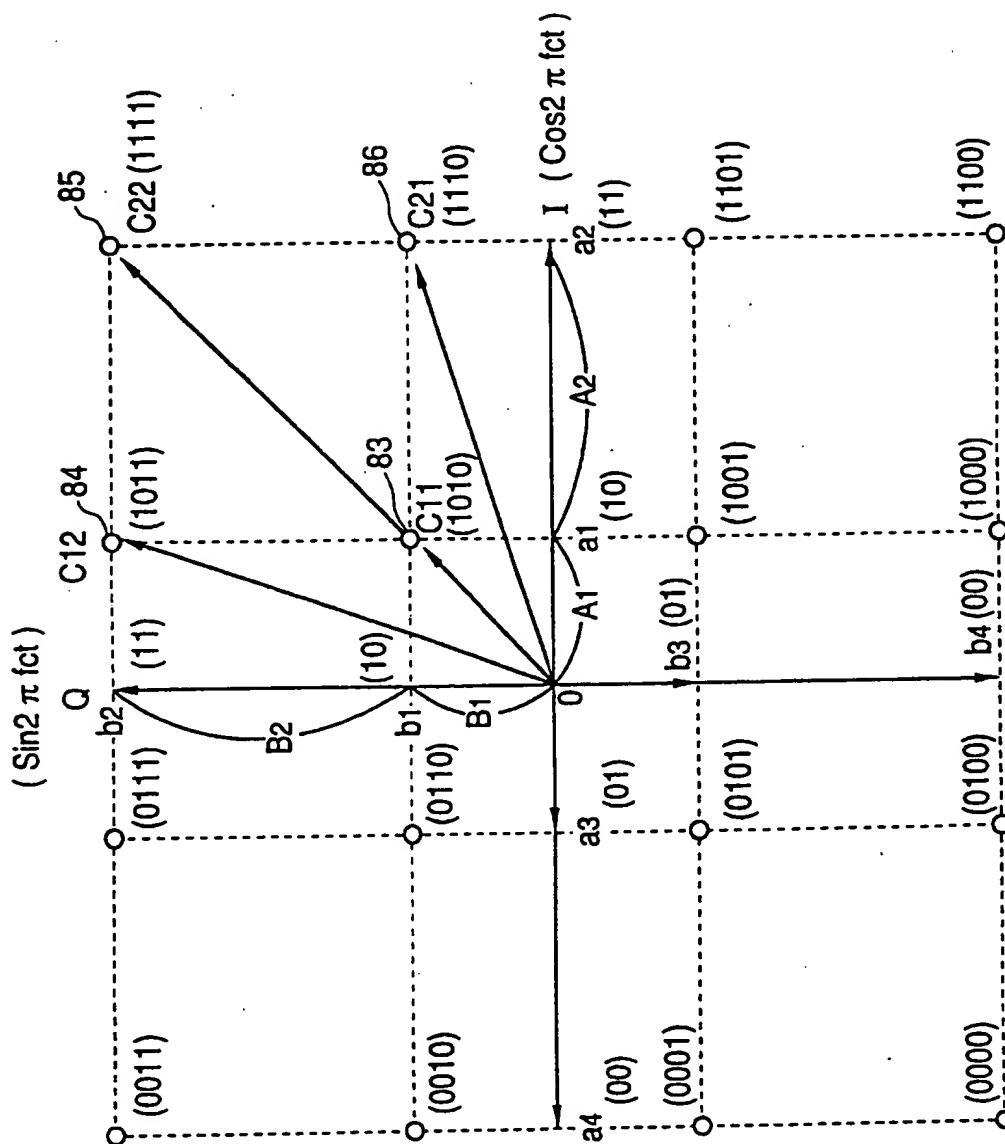


FIG. 5



0033001 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

FIG. 6

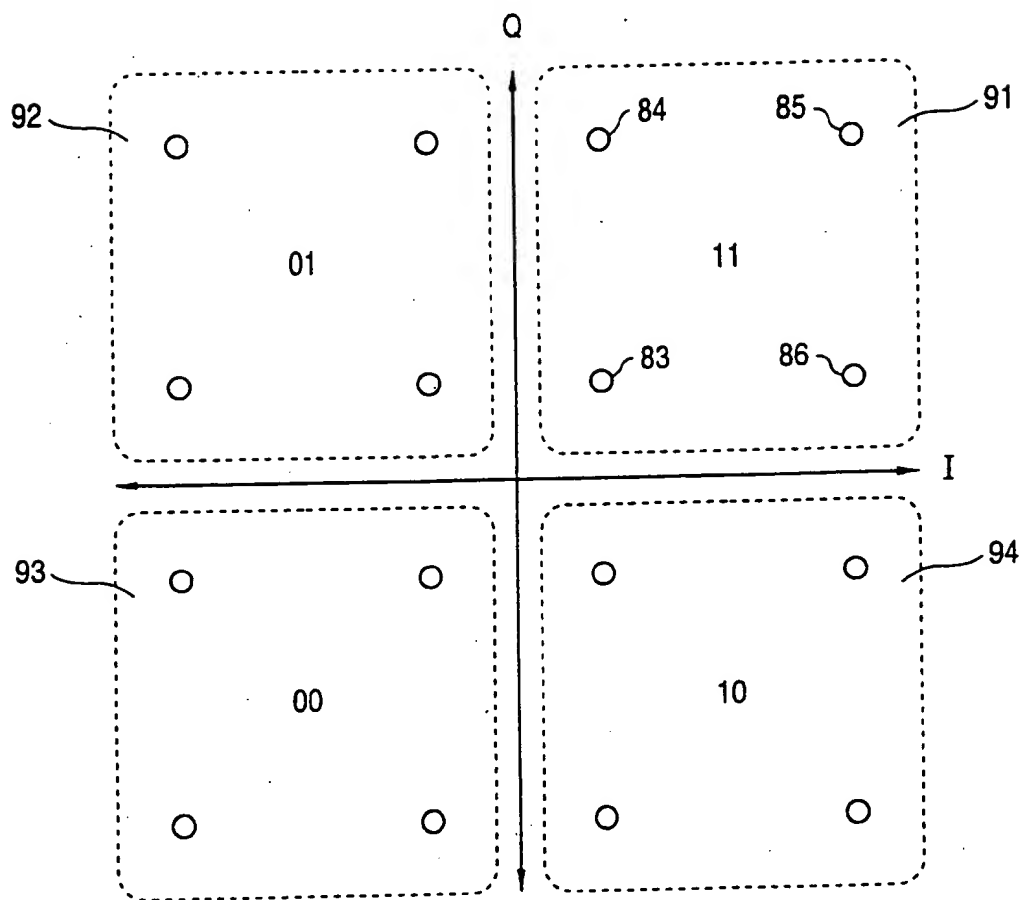


FIG. 7

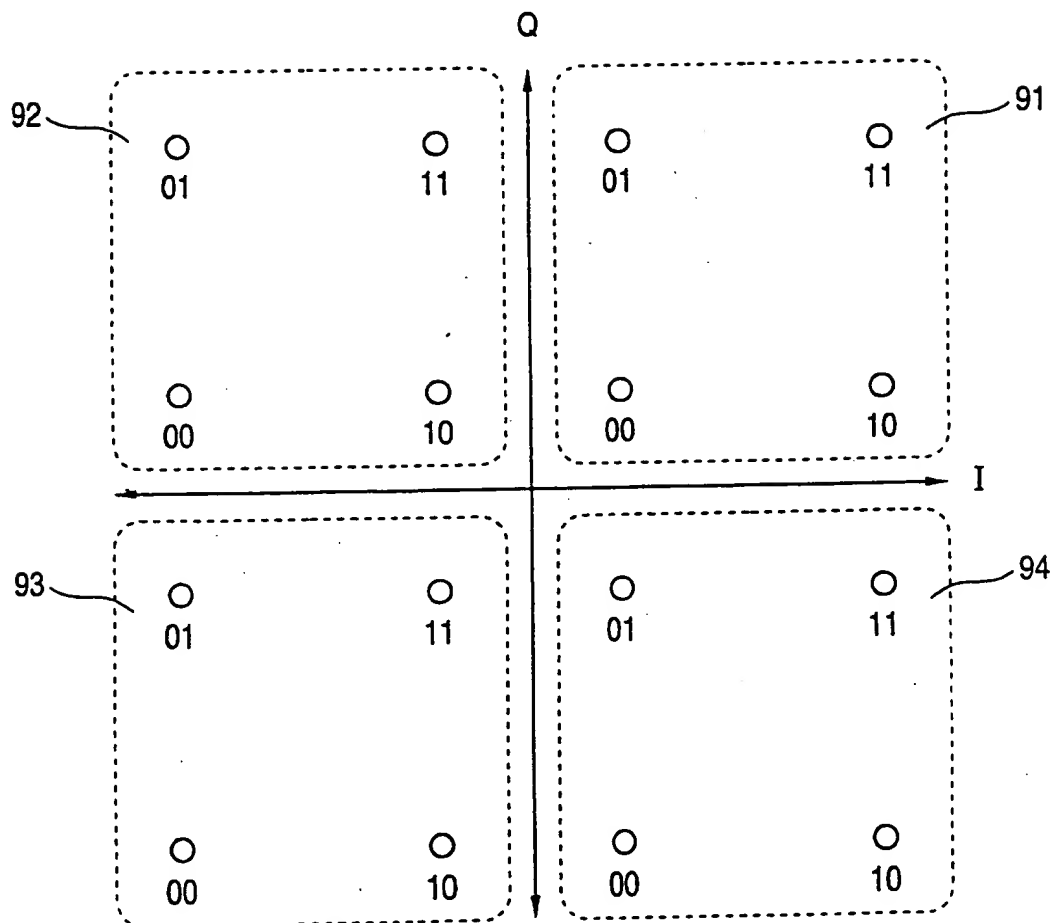


FIG. 8

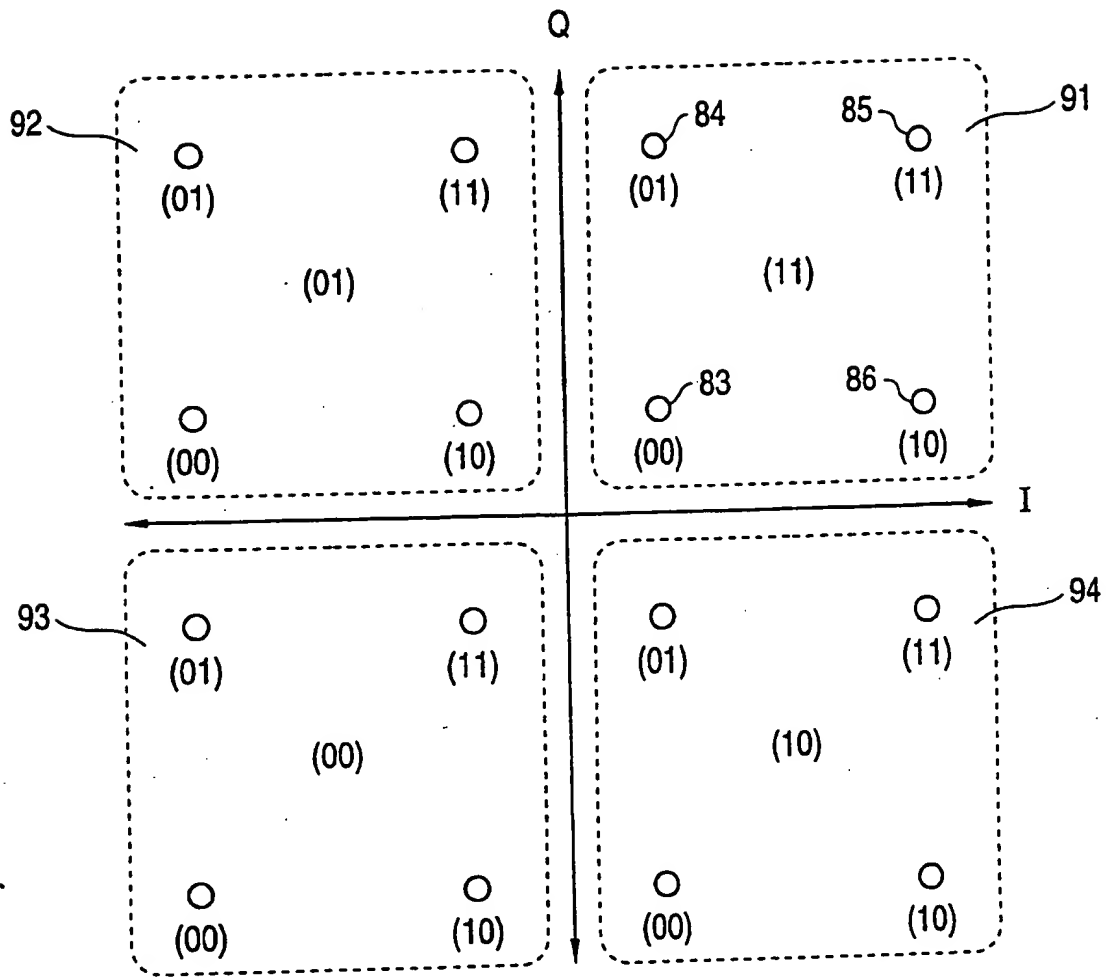


FIG. 9

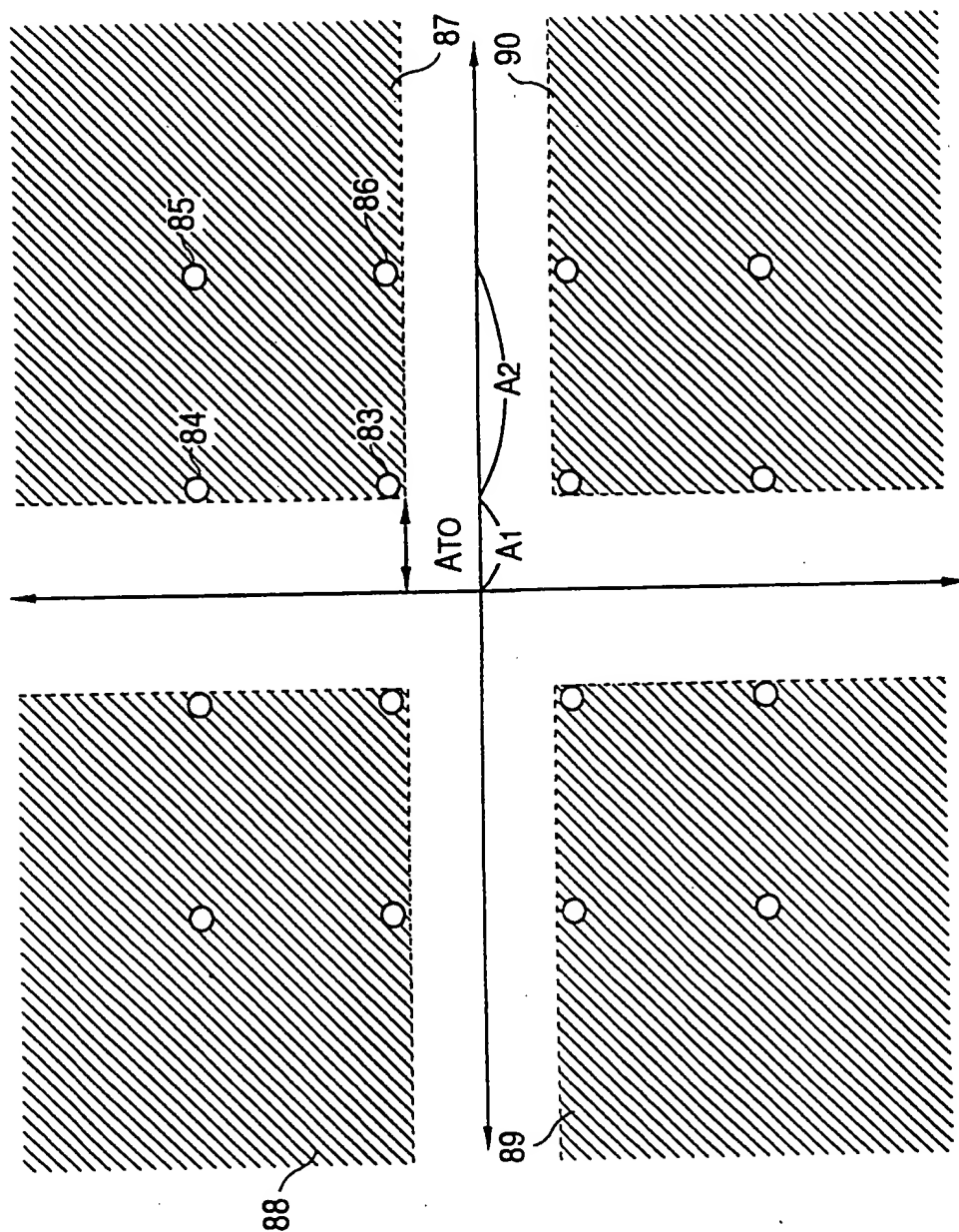


FIG. 10

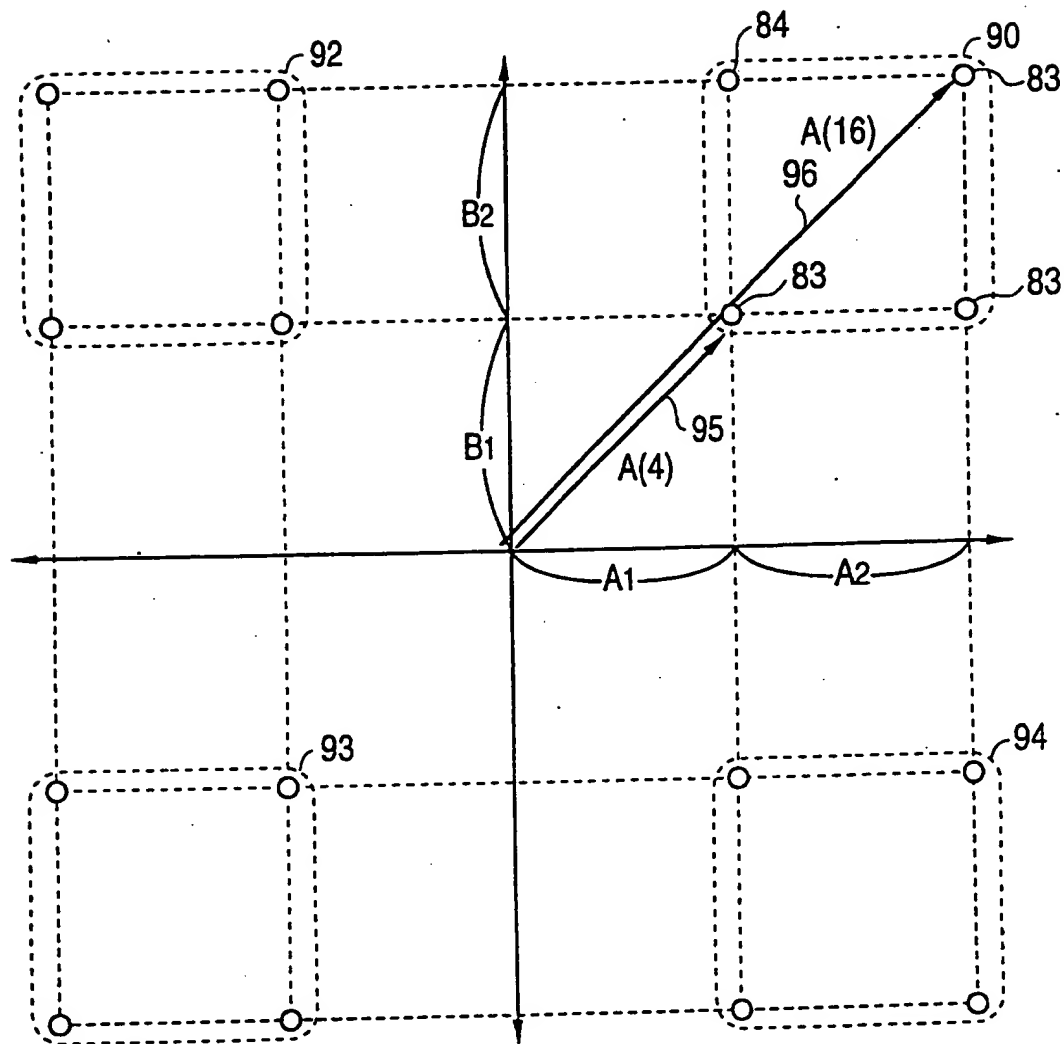


FIG. 11

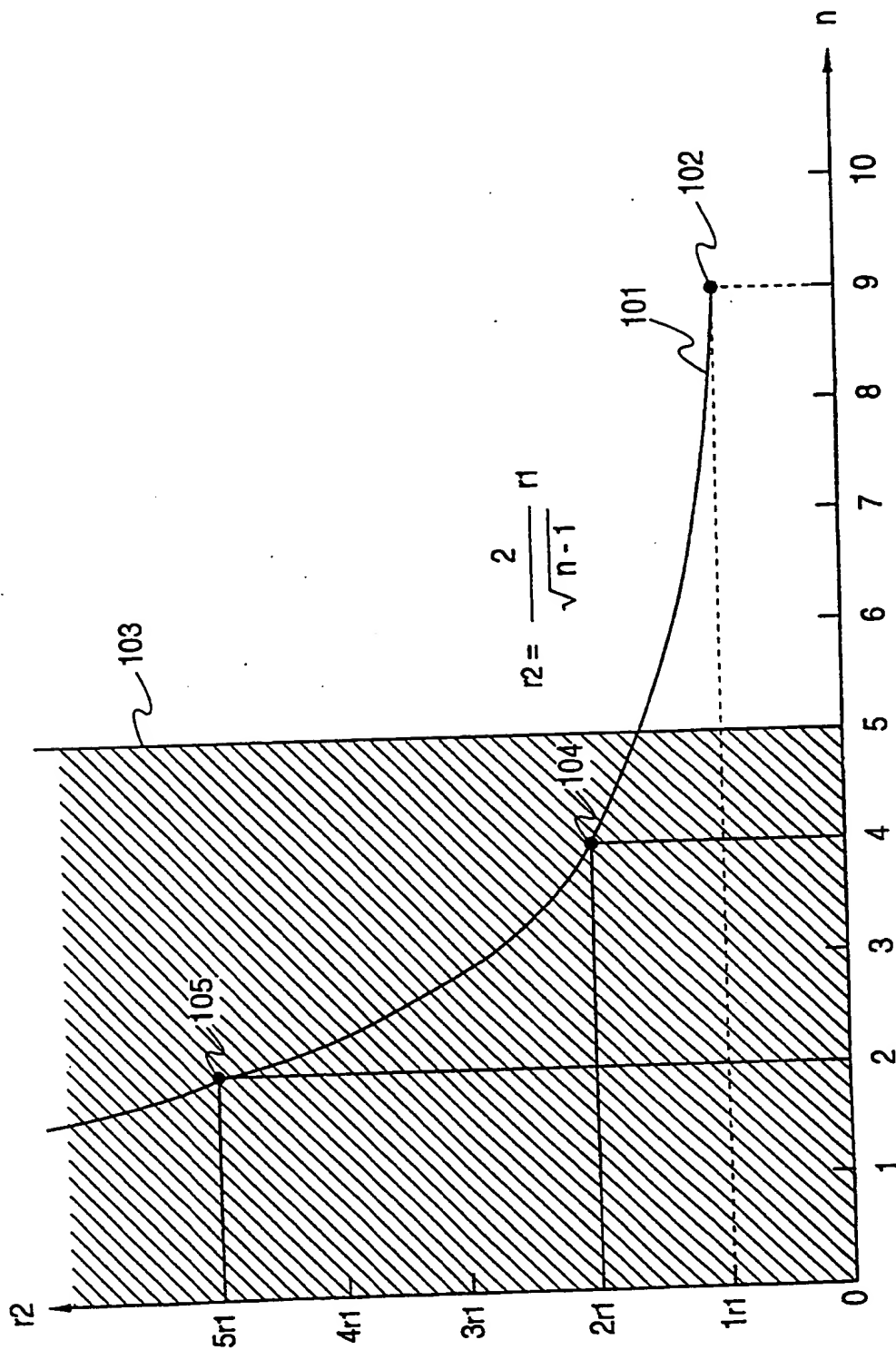


FIG. 12

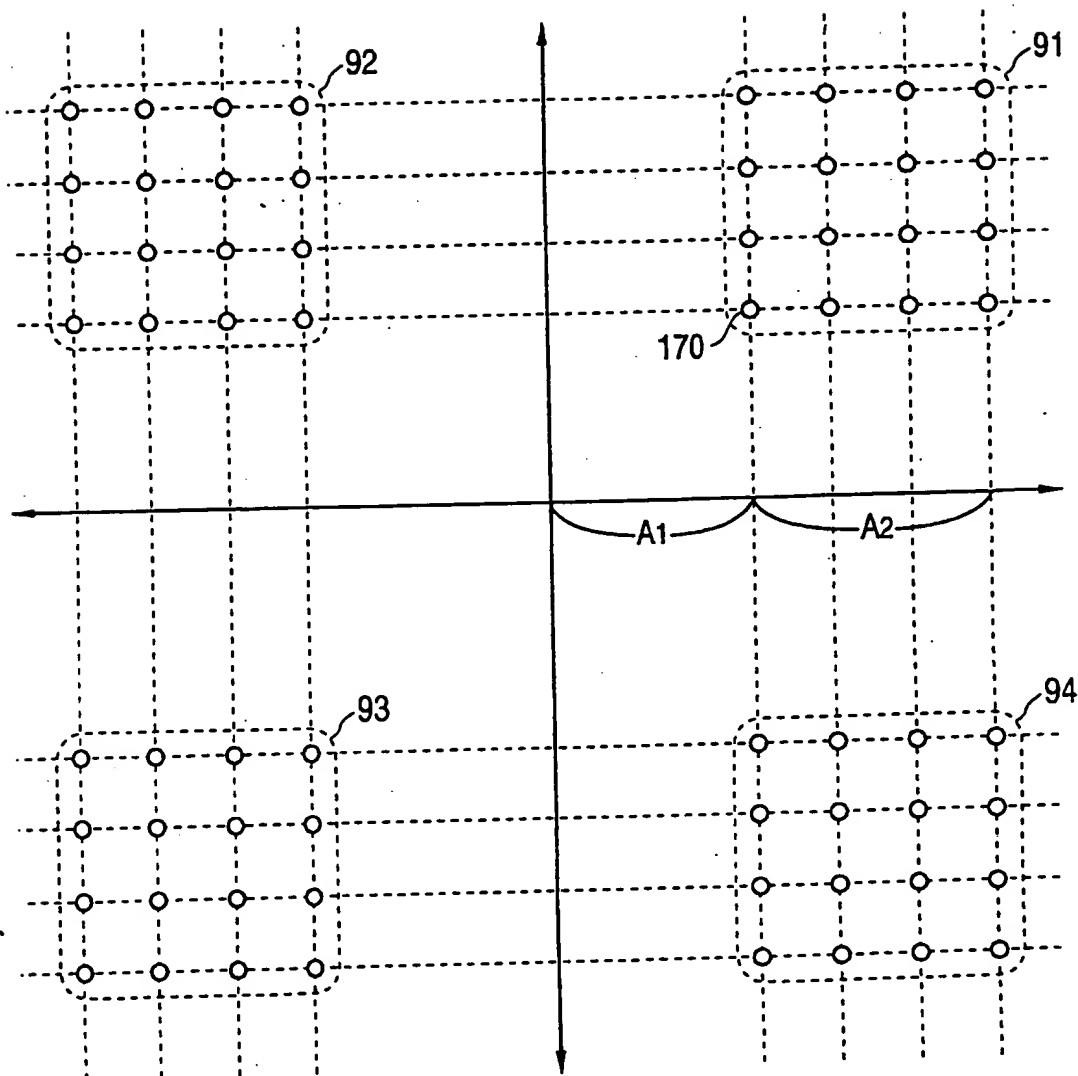


FIG. 13

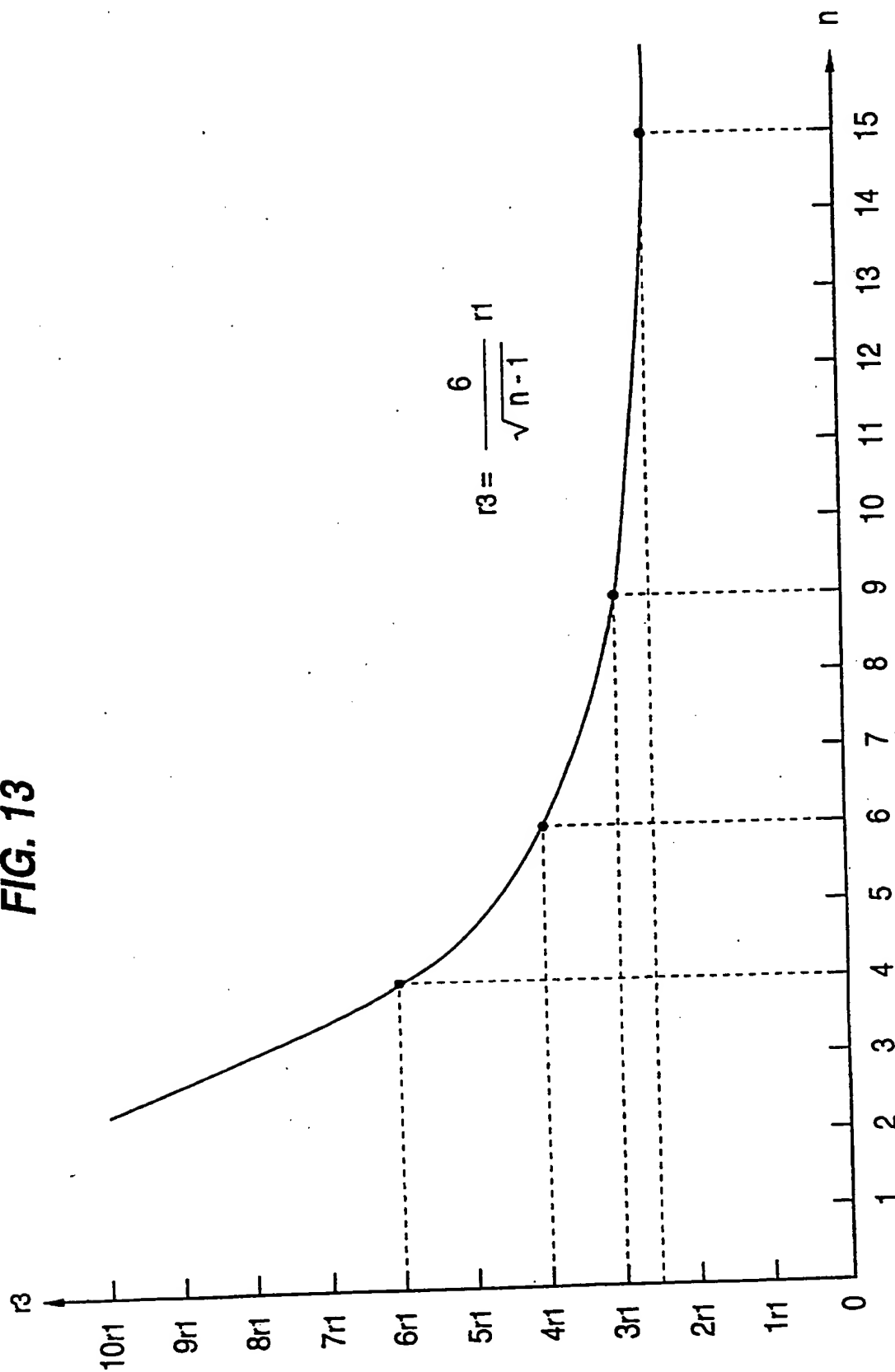


FIG. 14

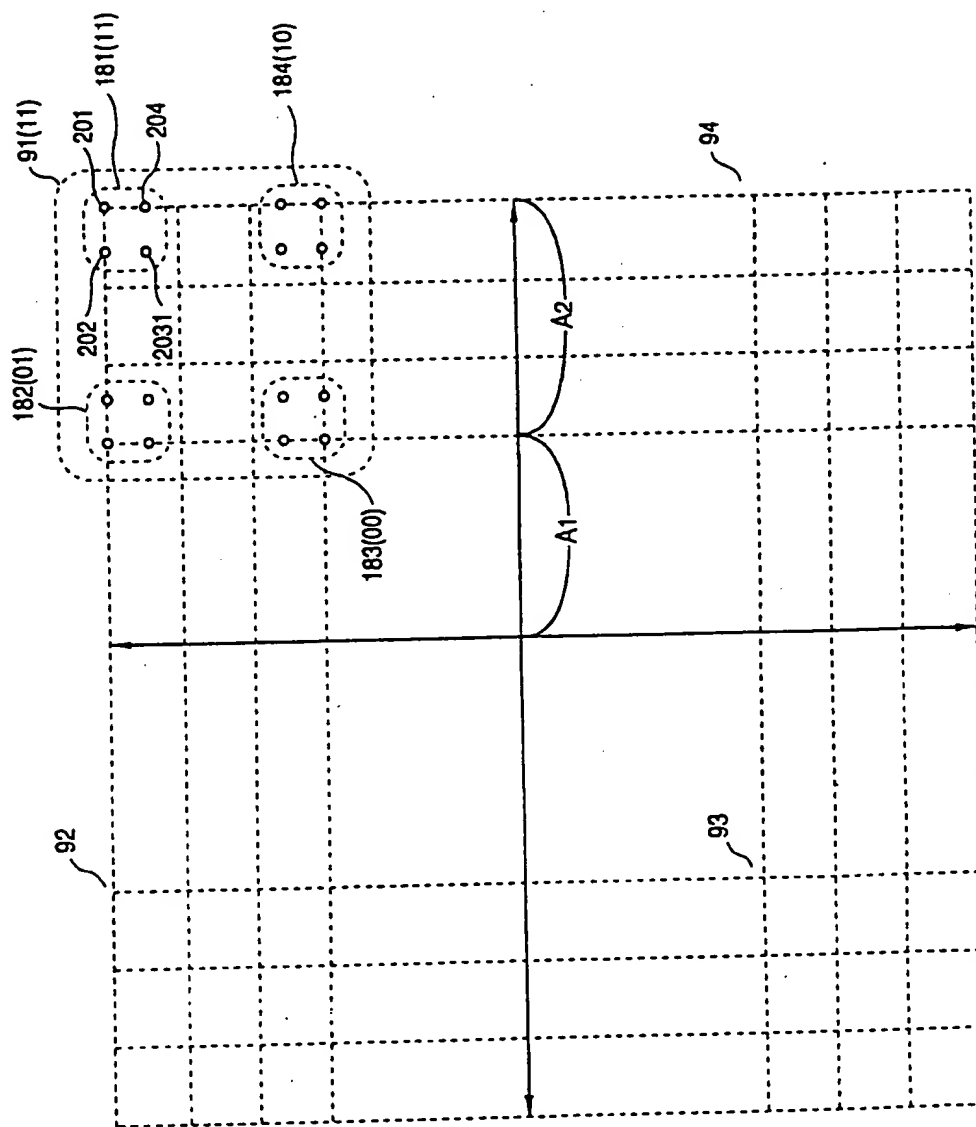


FIG. 15

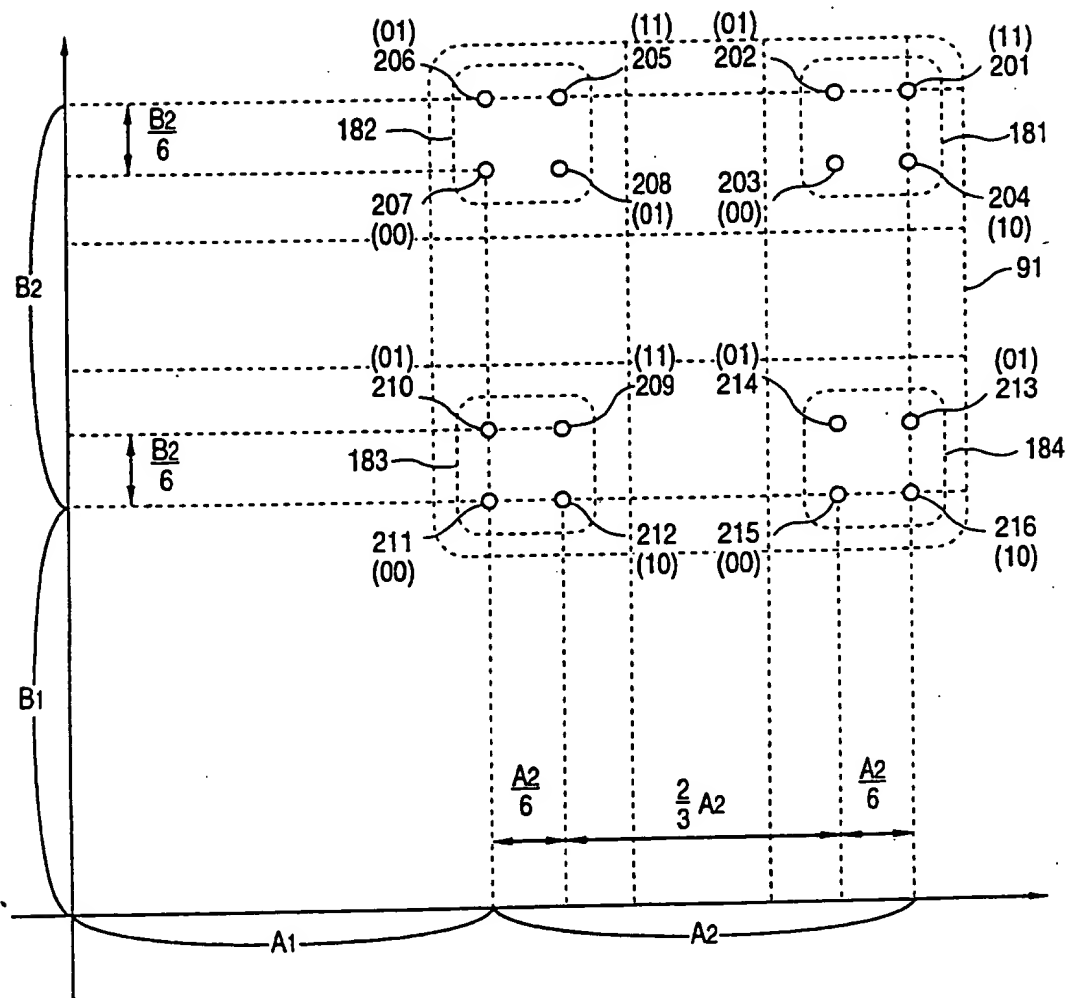


FIG. 16

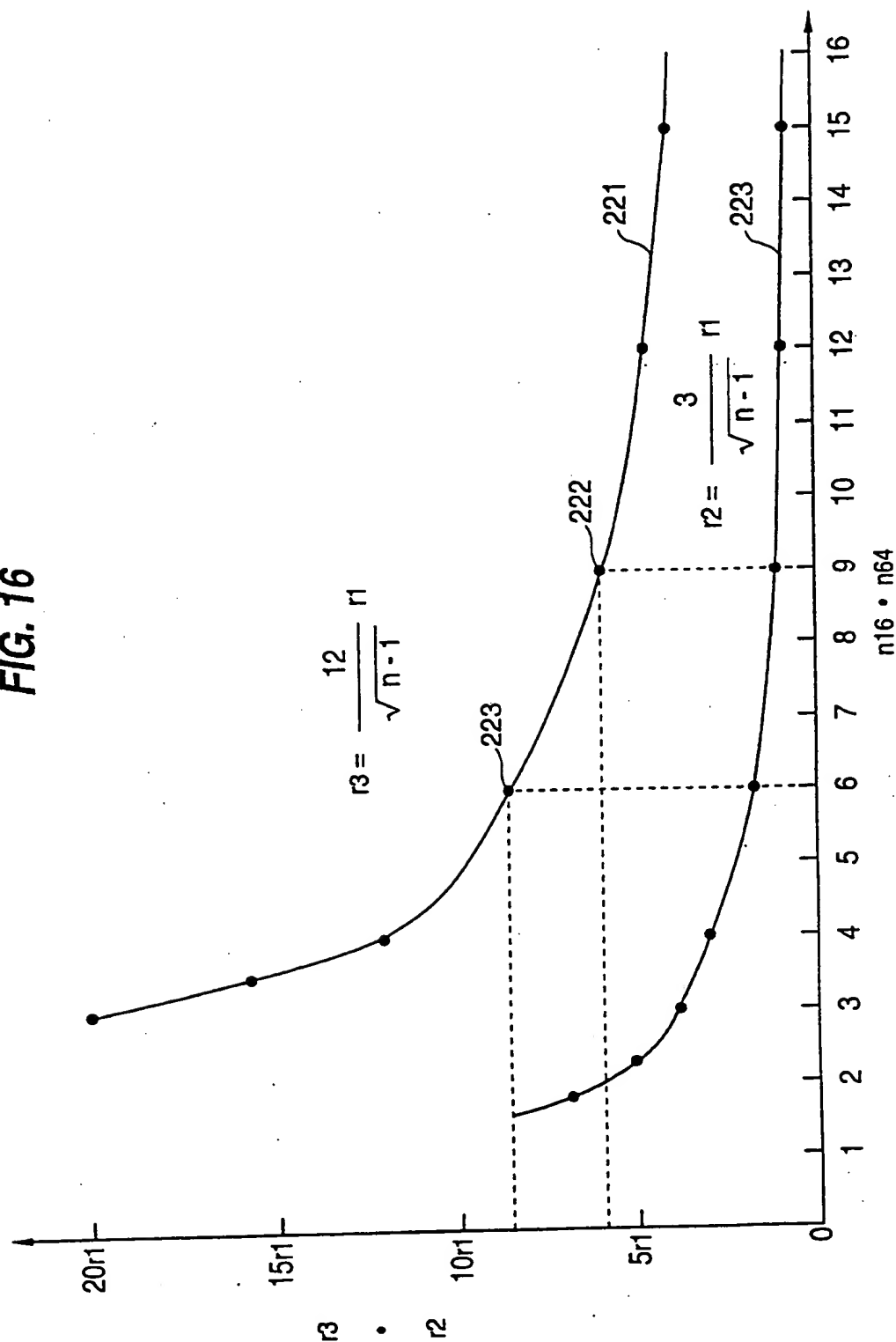


FIG. 17

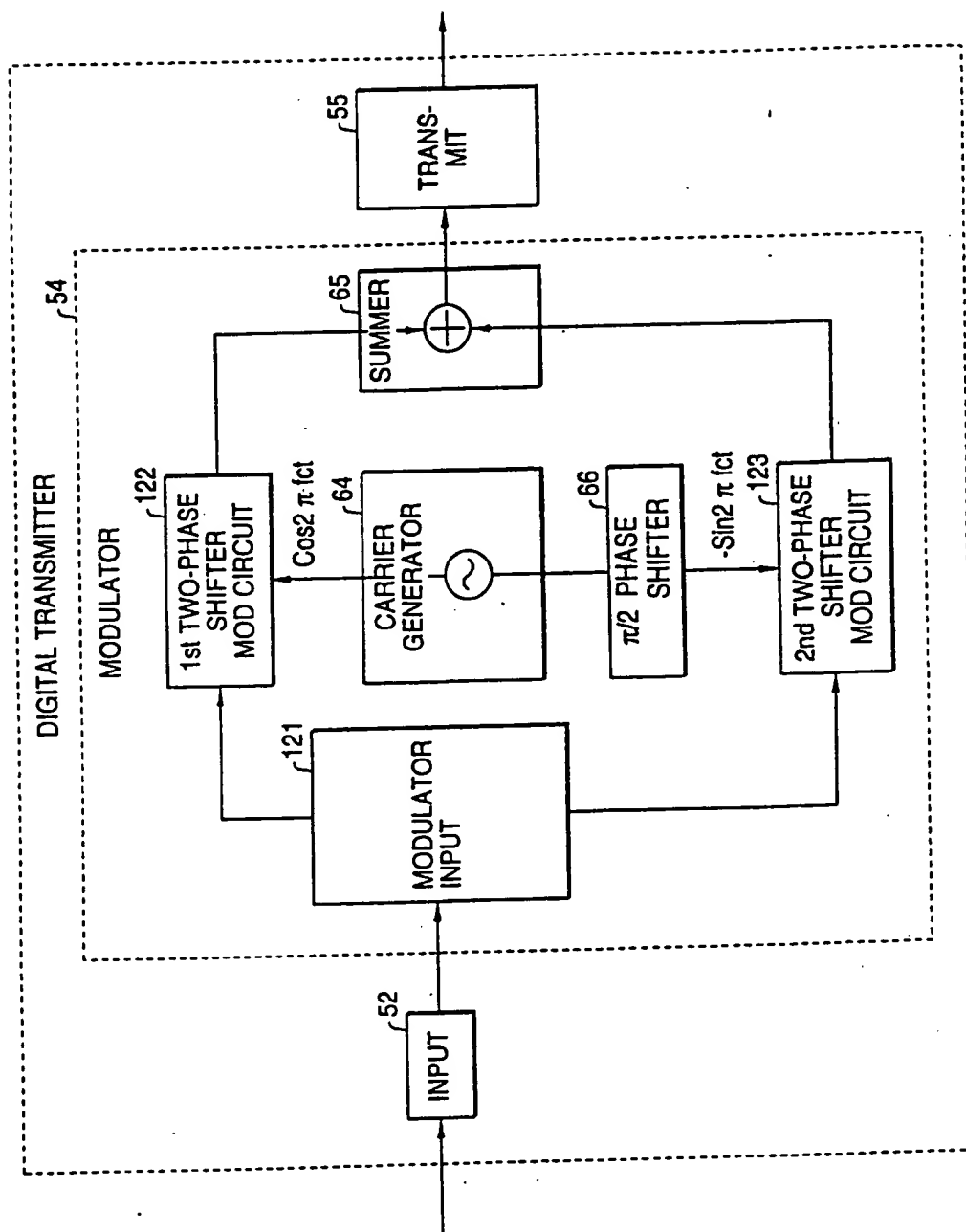


FIG. 18

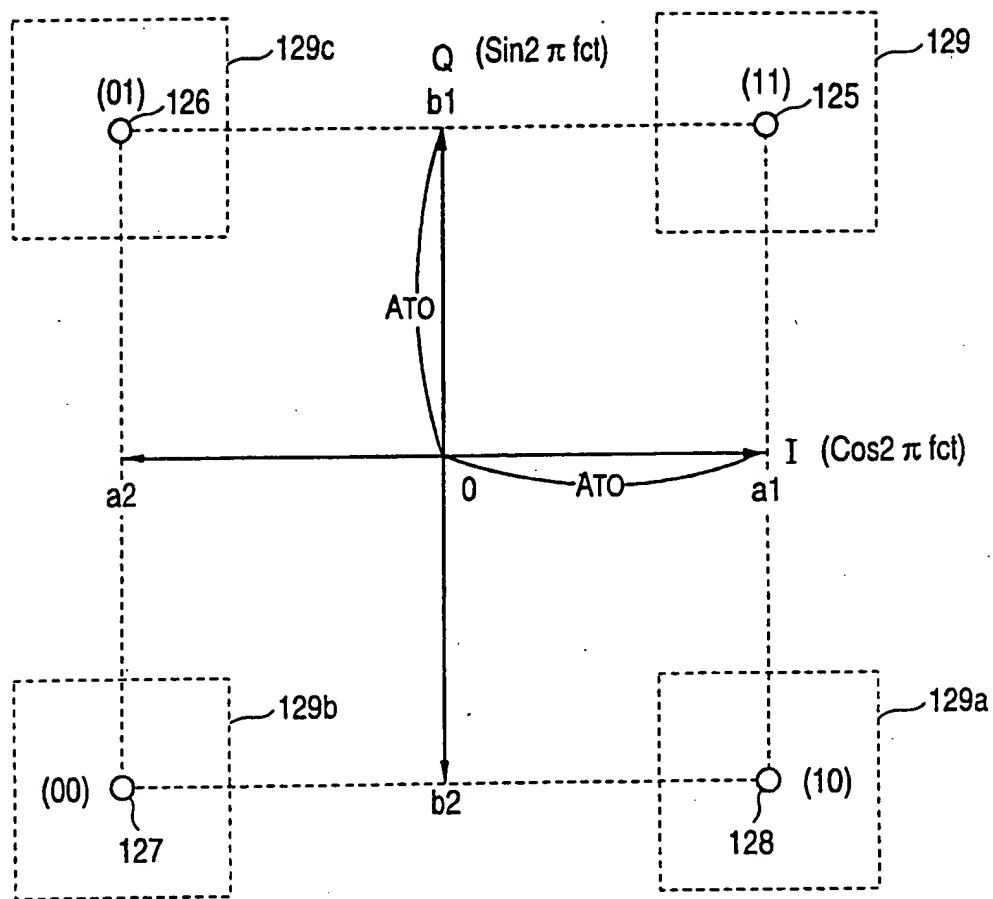


FIG. 19

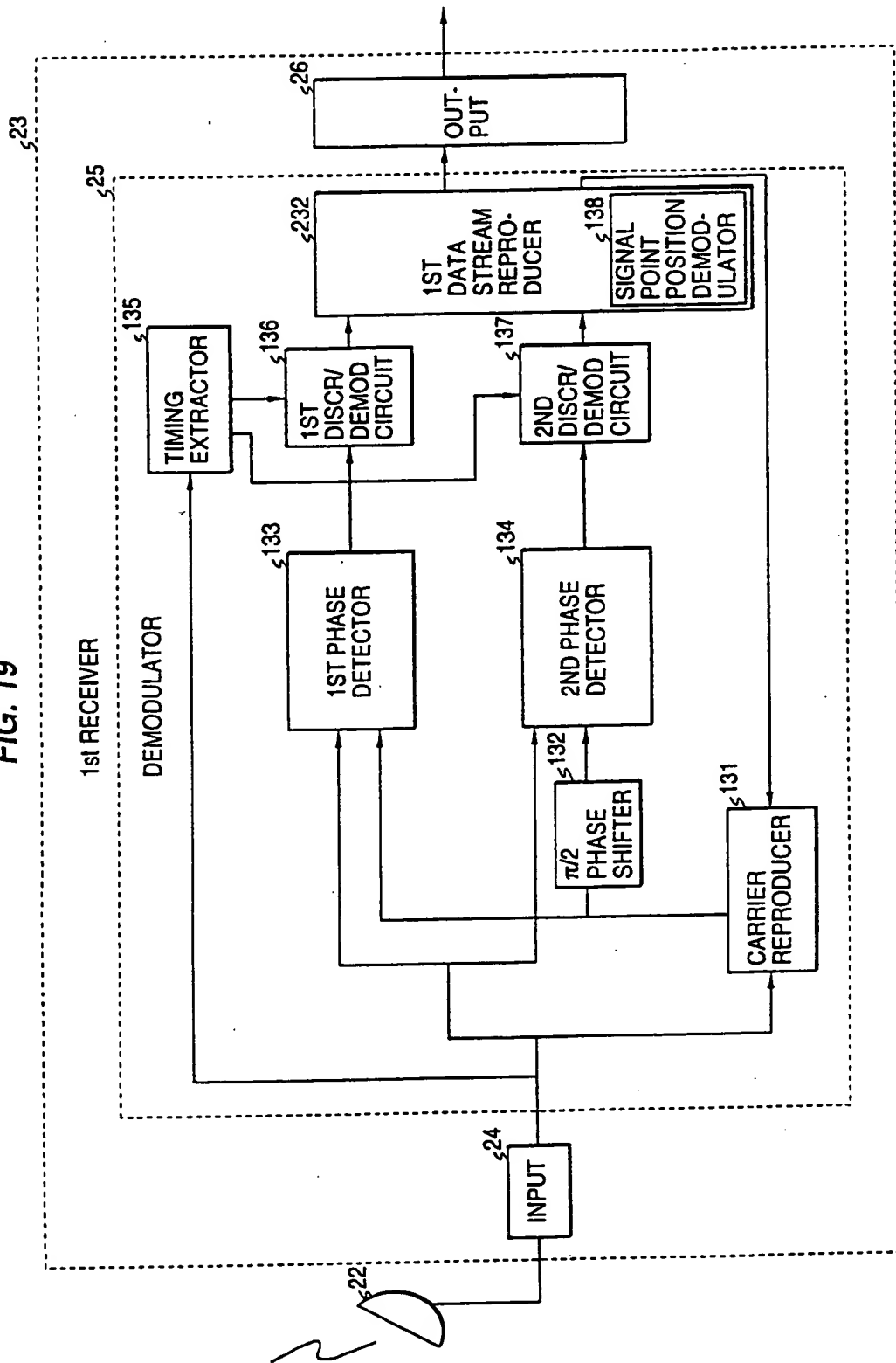
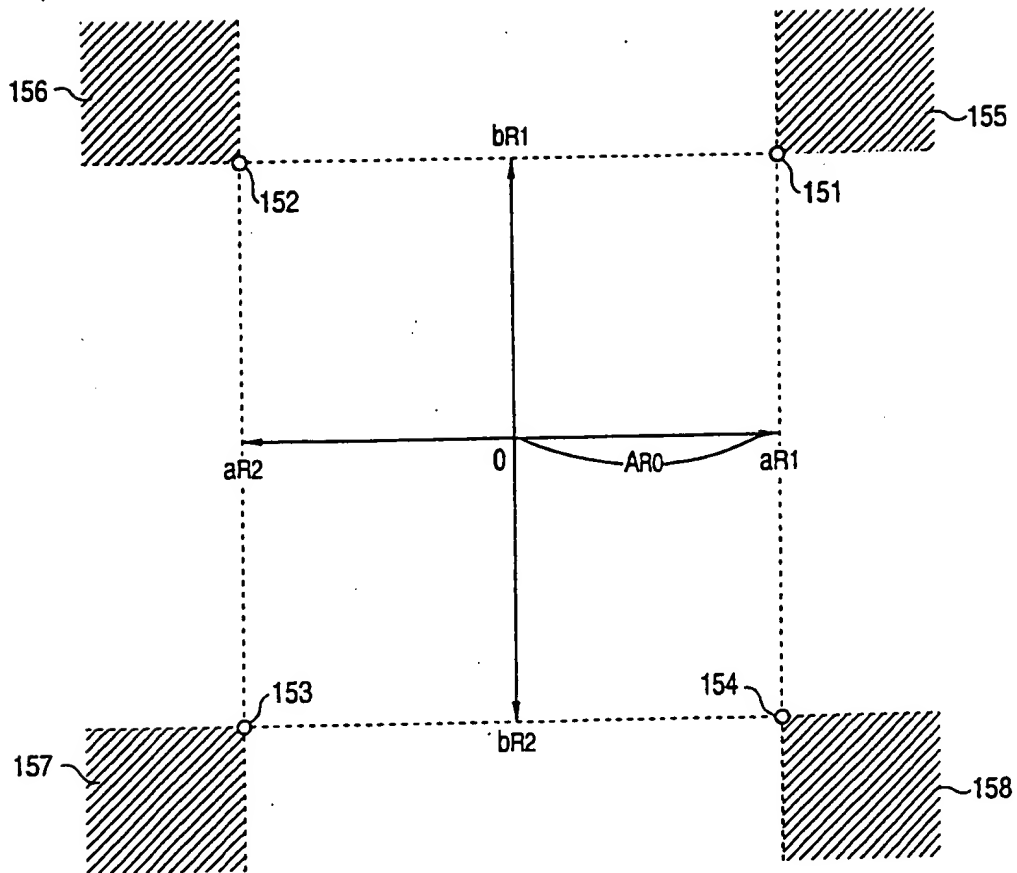


FIG. 20



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FIG. 21

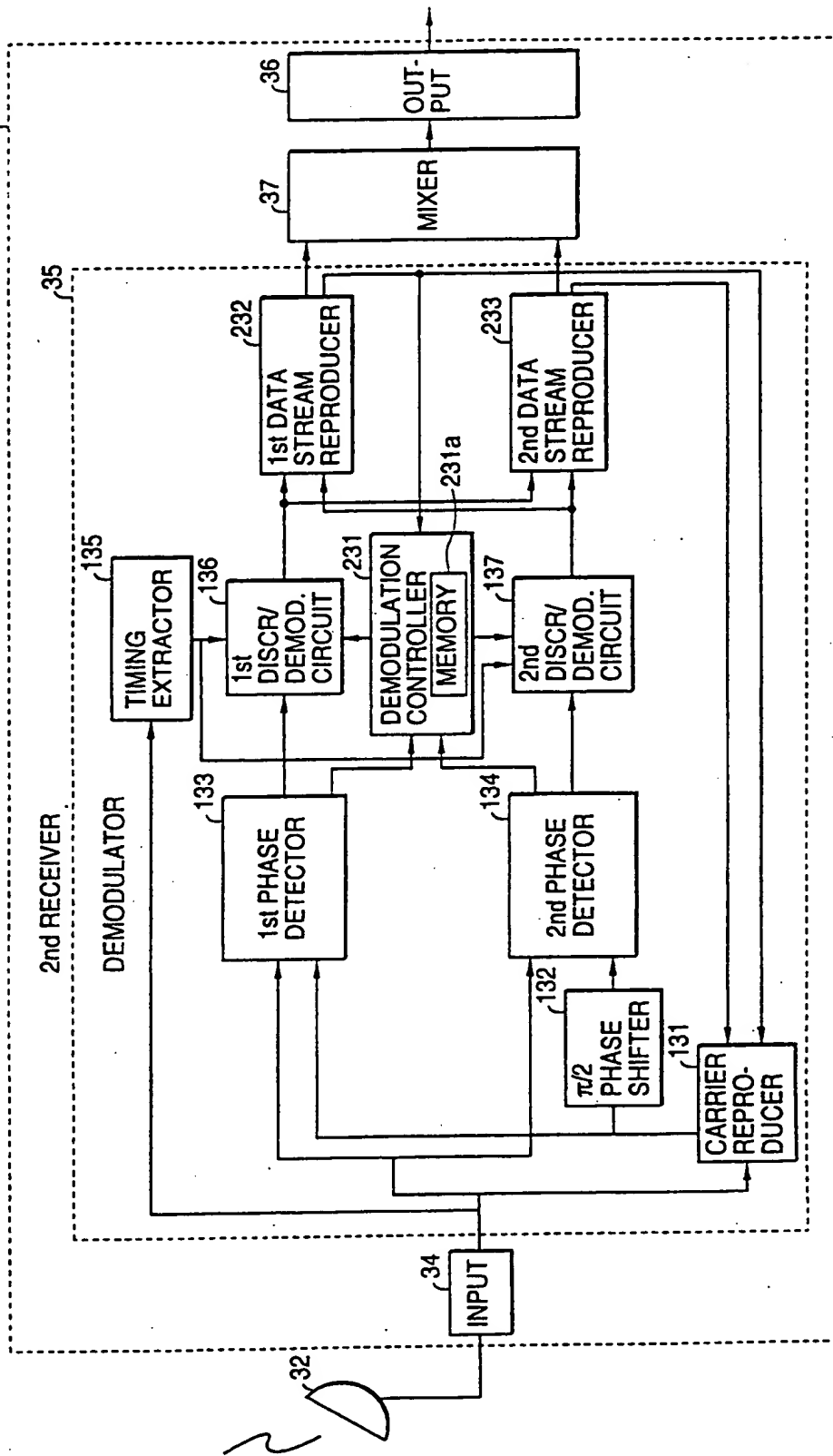
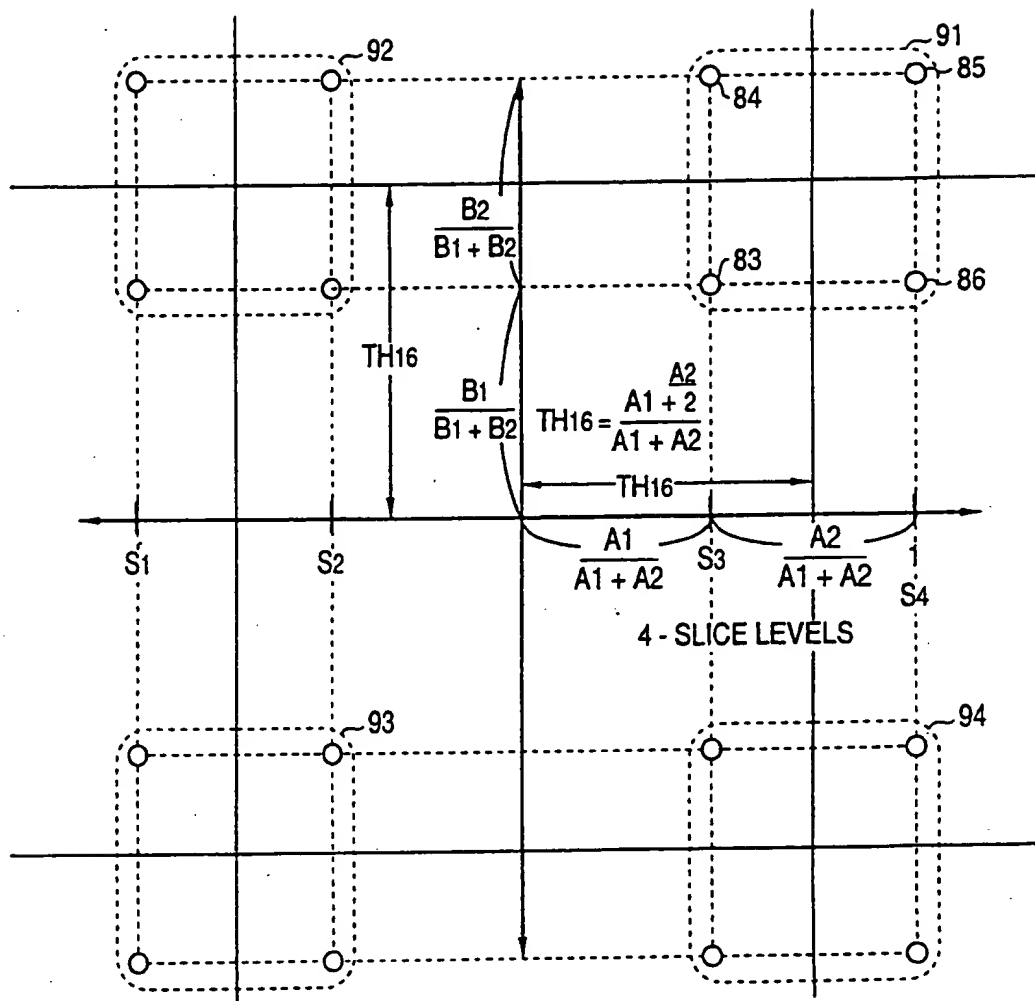


FIG. 22



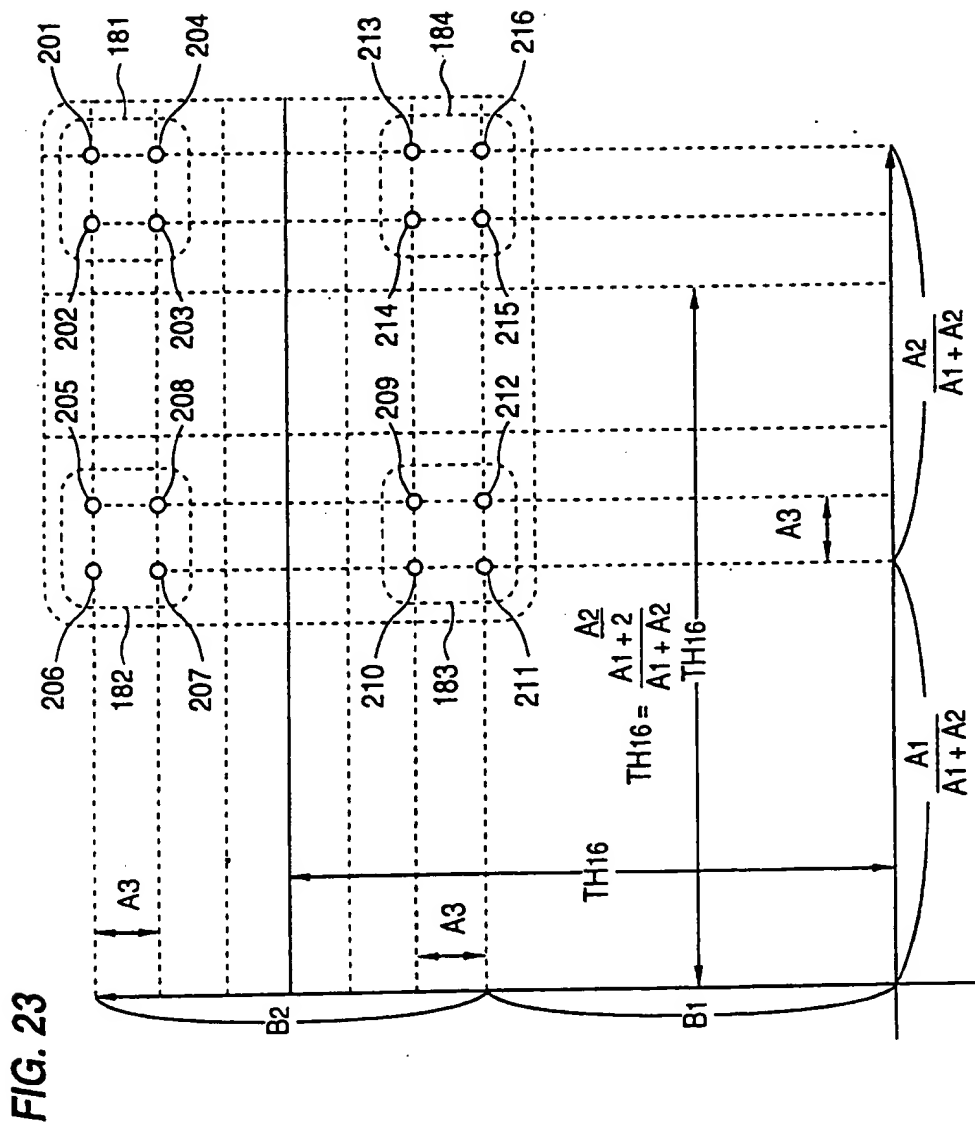


FIG. 24

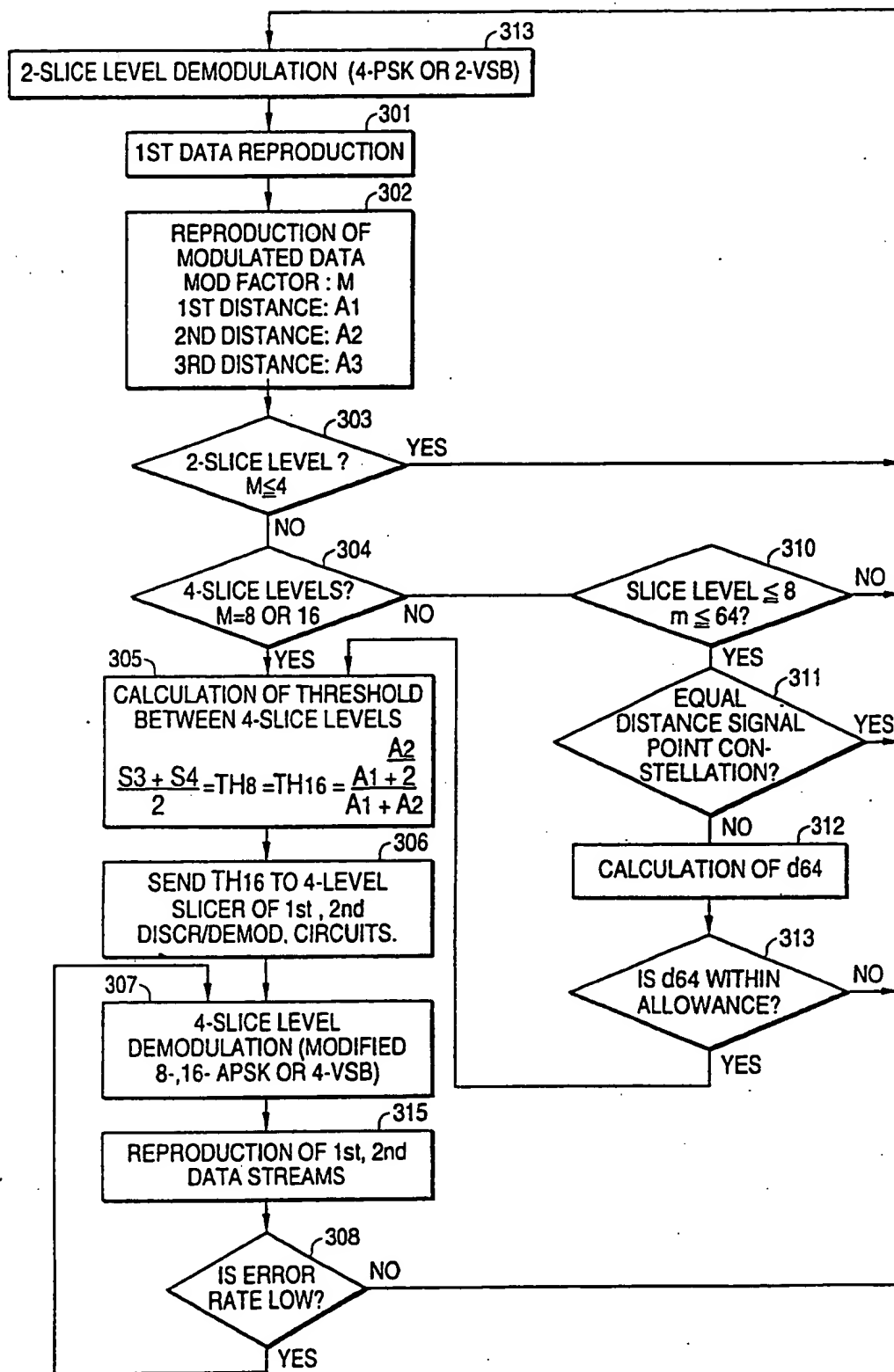


FIG. 25(a)

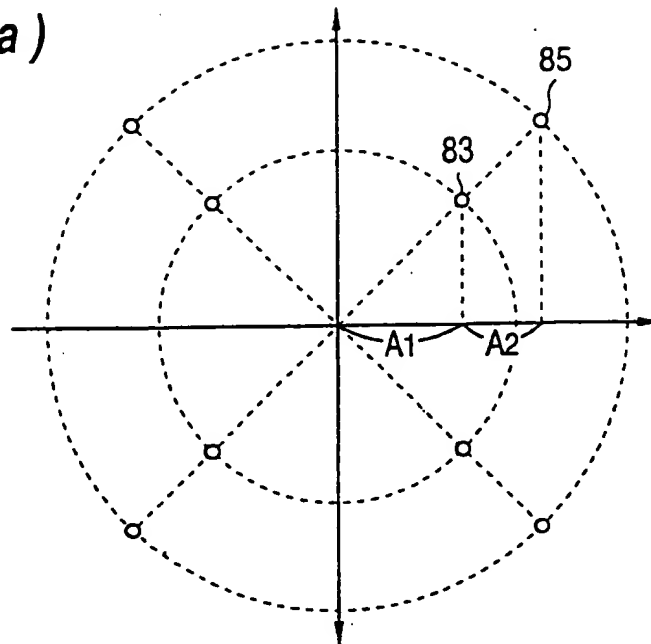


FIG. 25(b)

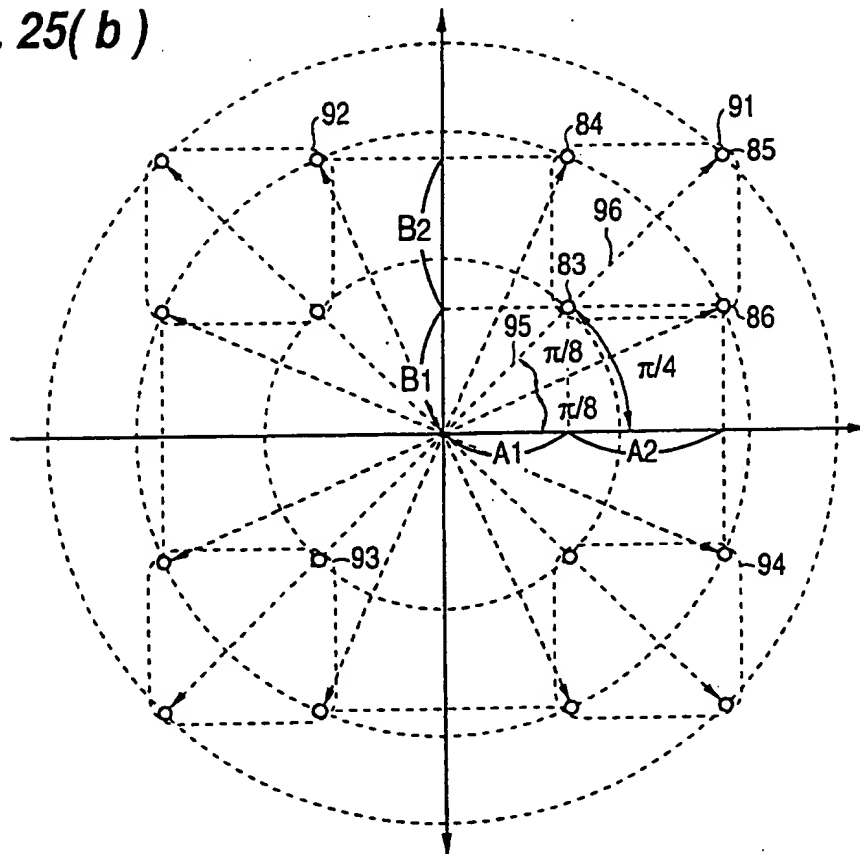
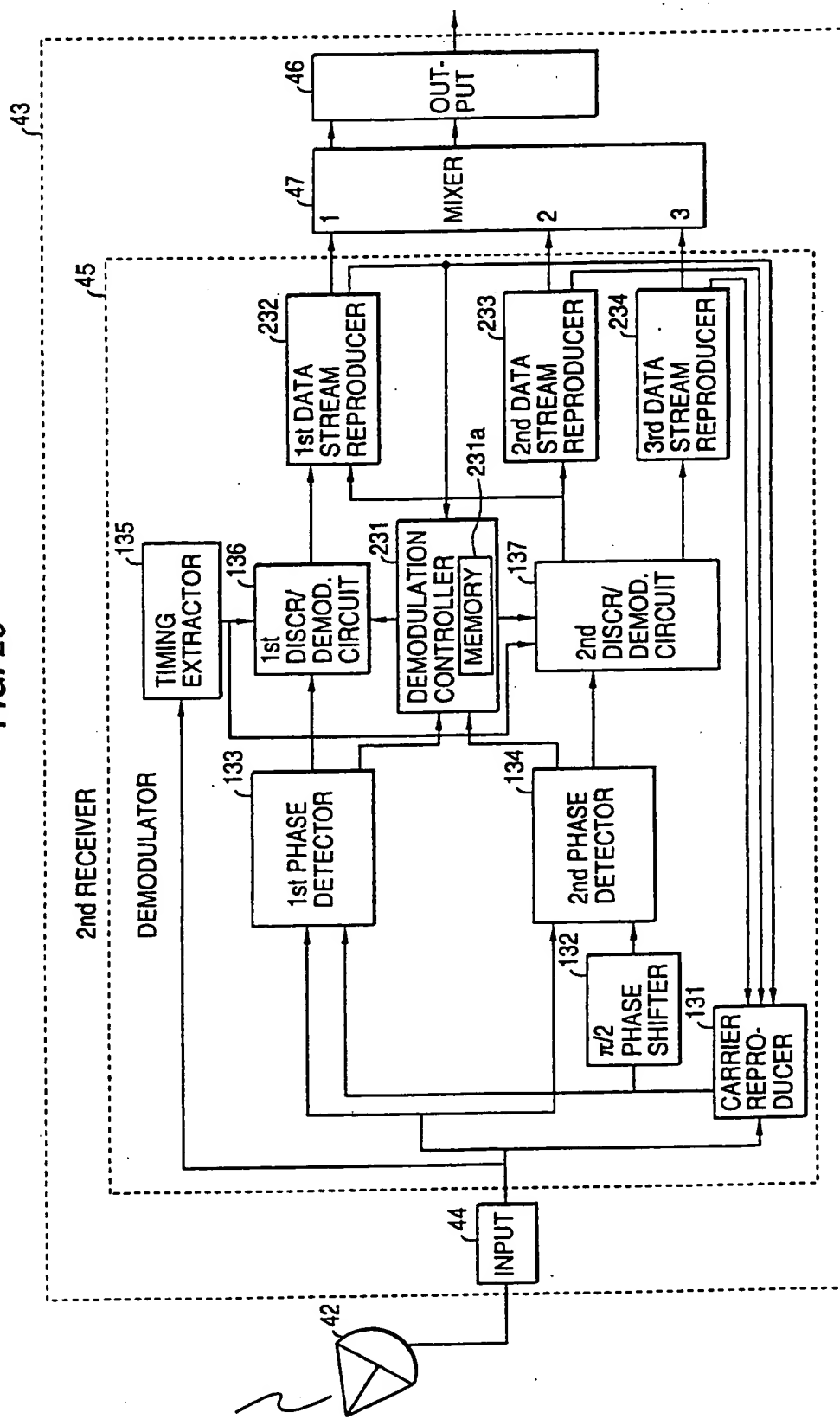


FIG. 26



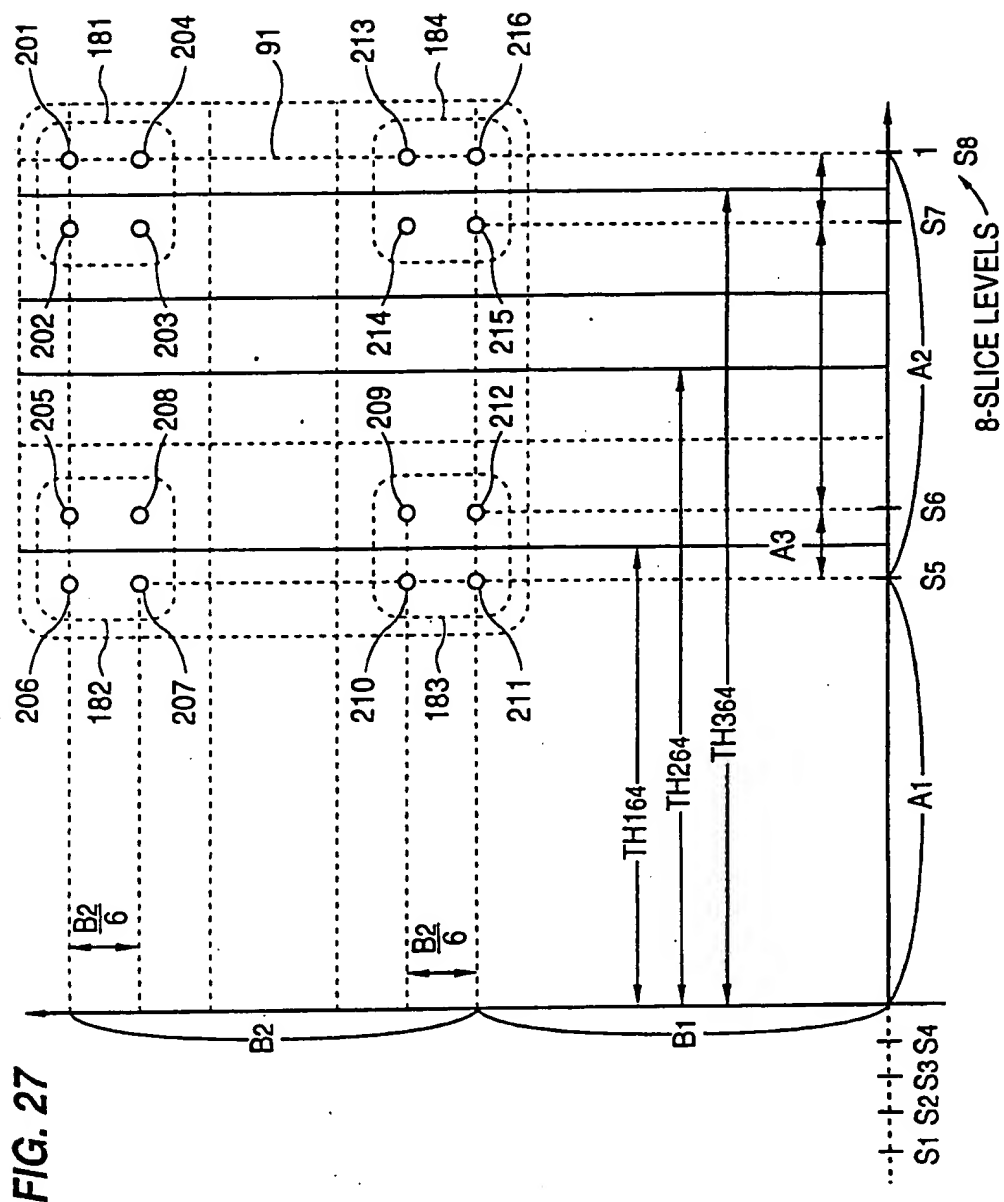


FIG. 28

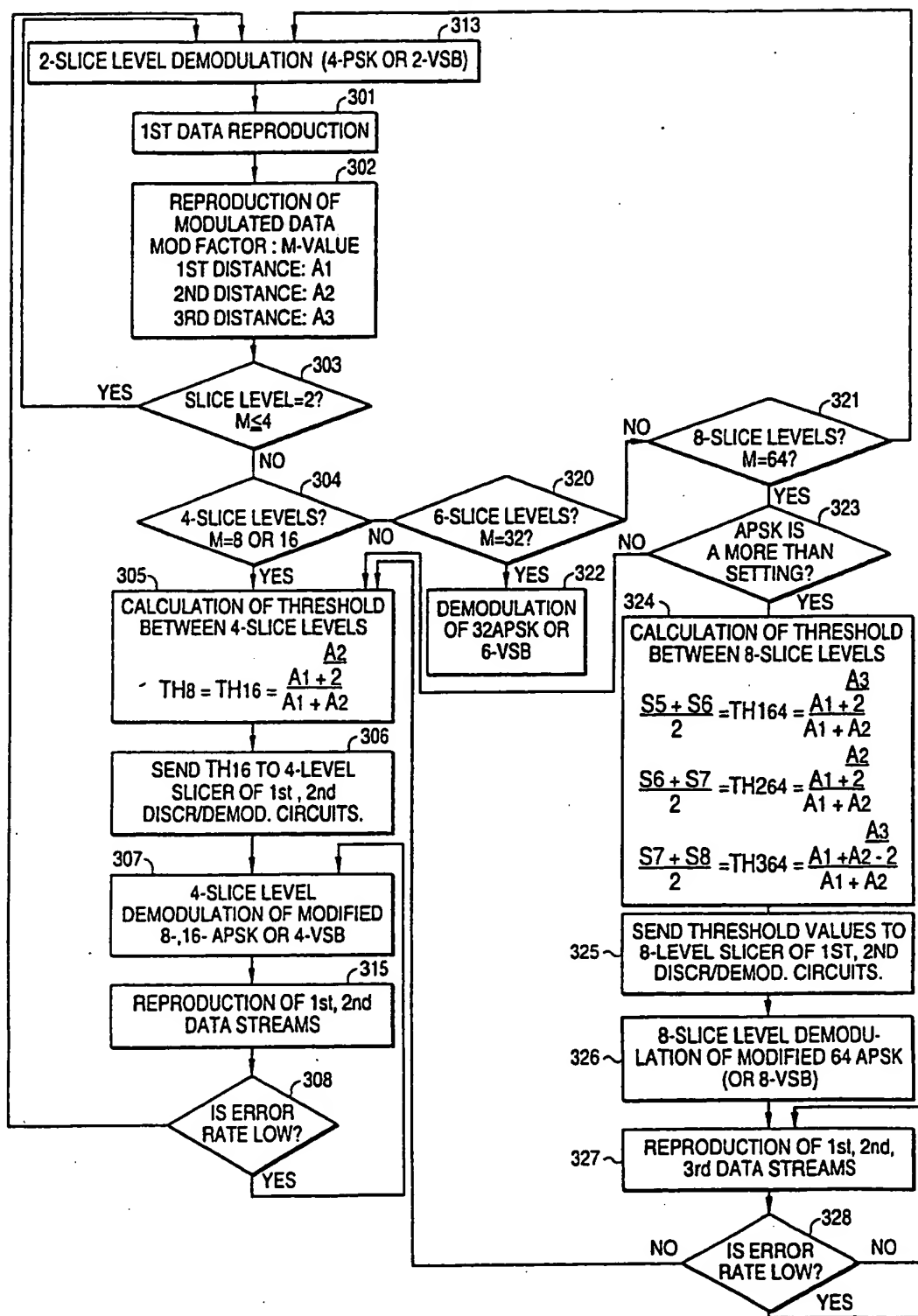


FIG. 29

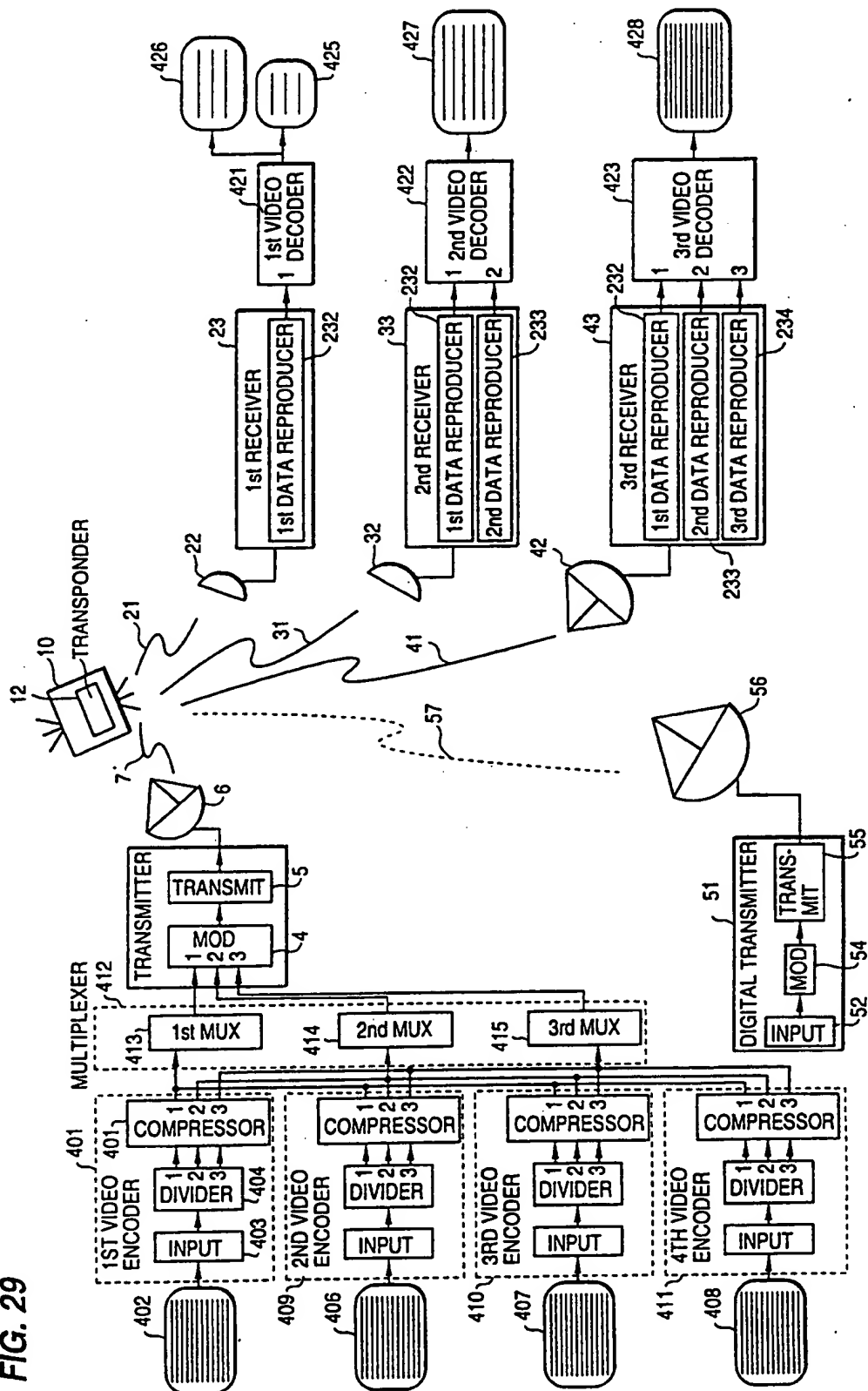
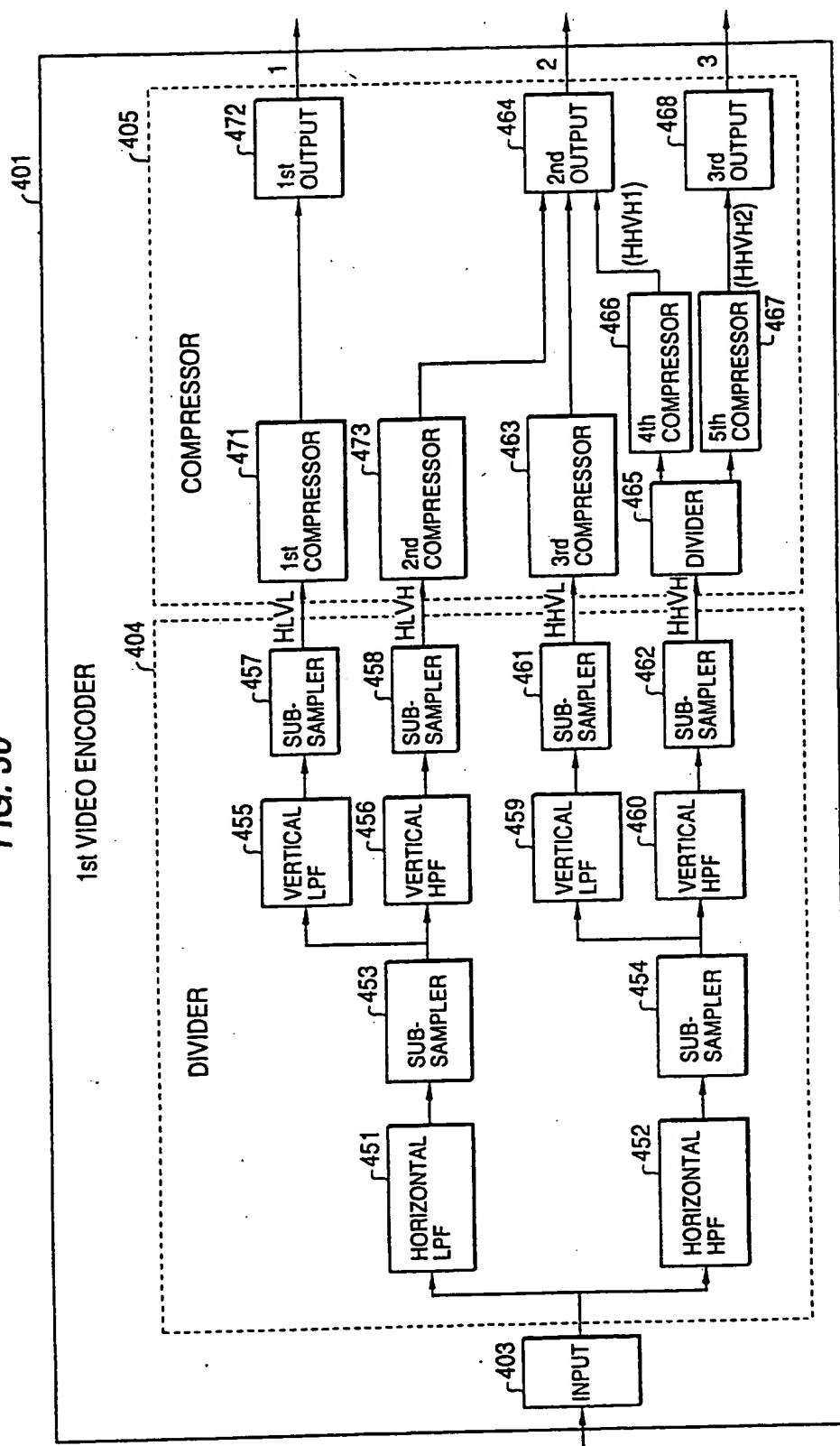


FIG. 30



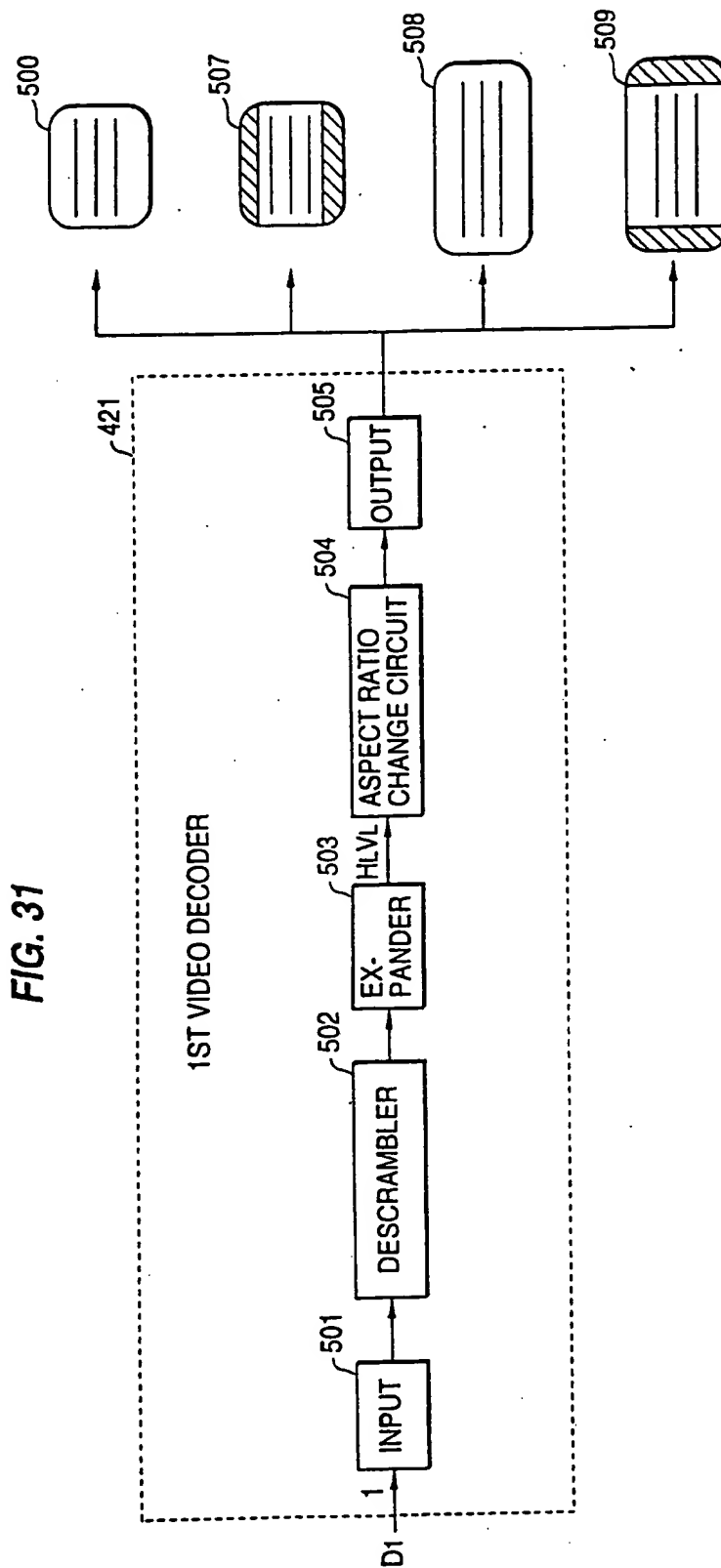


FIG. 31

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FIG. 32

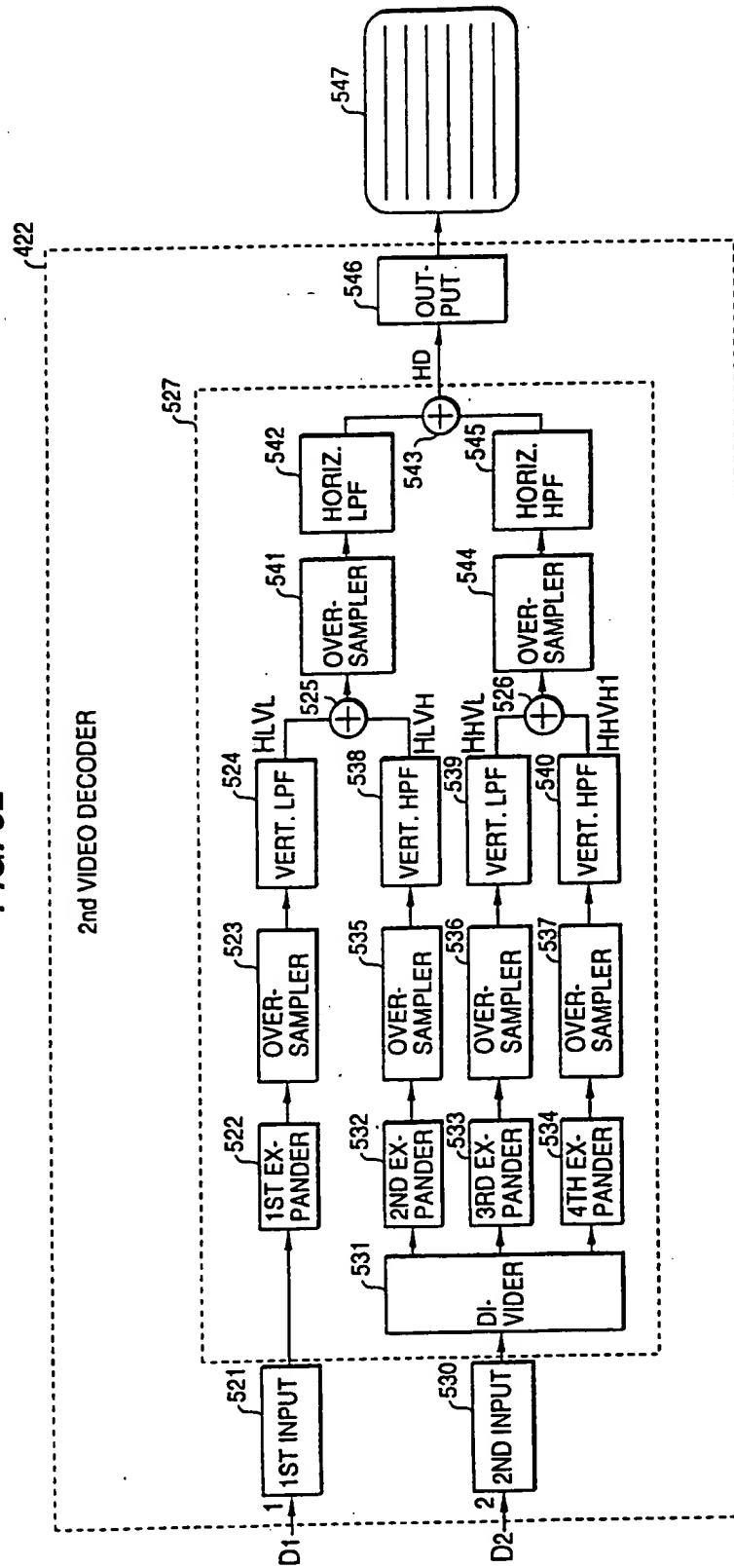


FIG. 33

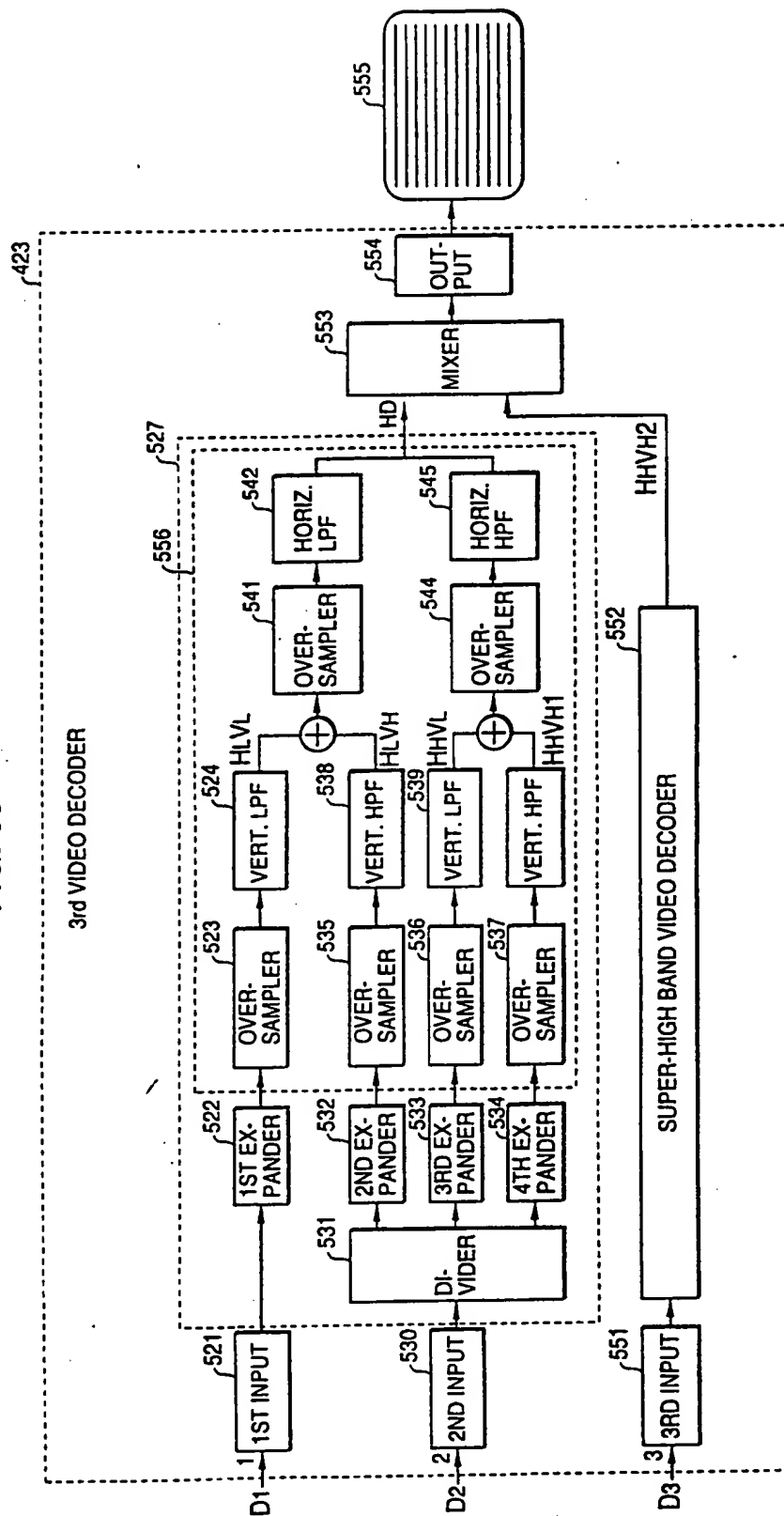


FIG. 34

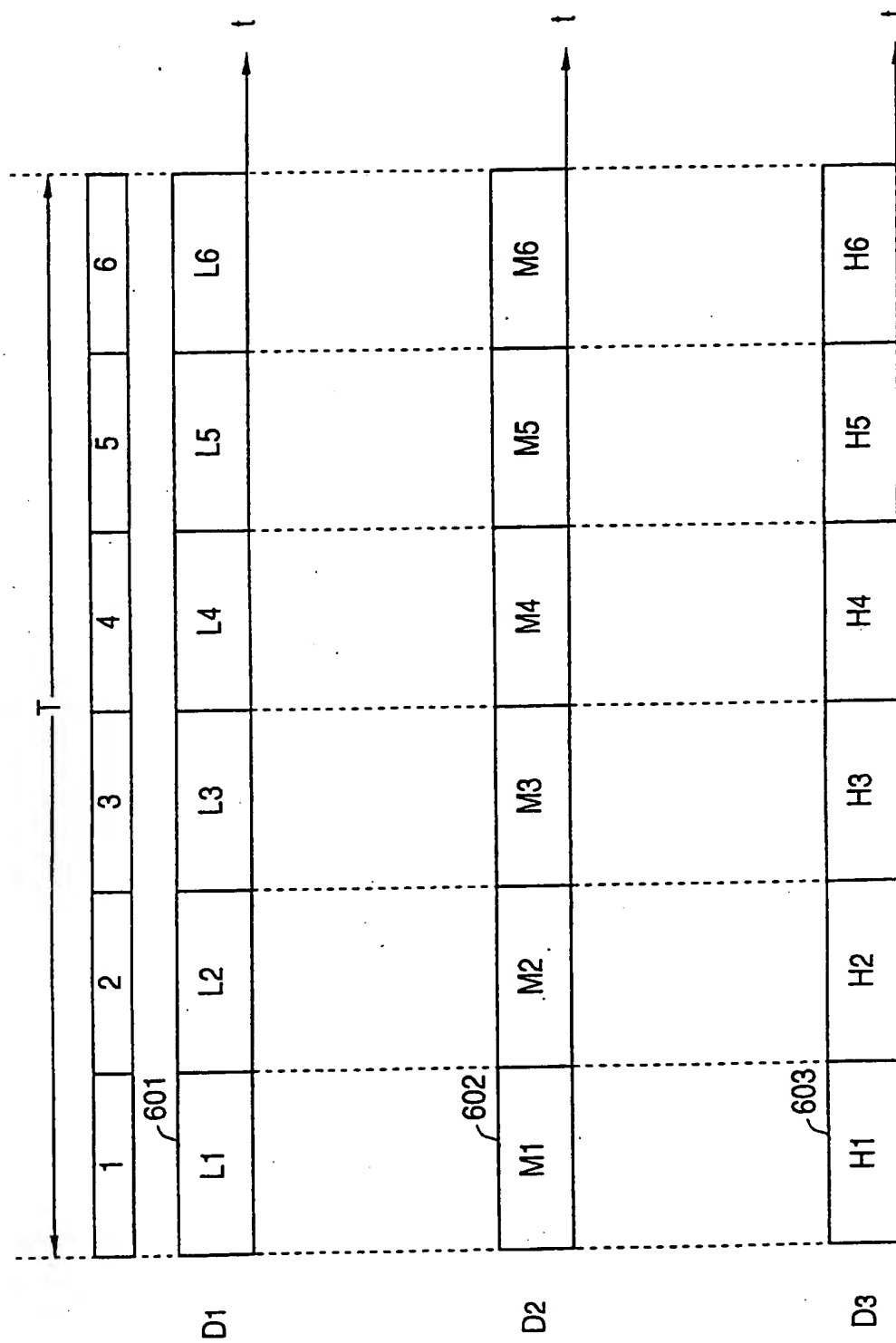


FIG. 35

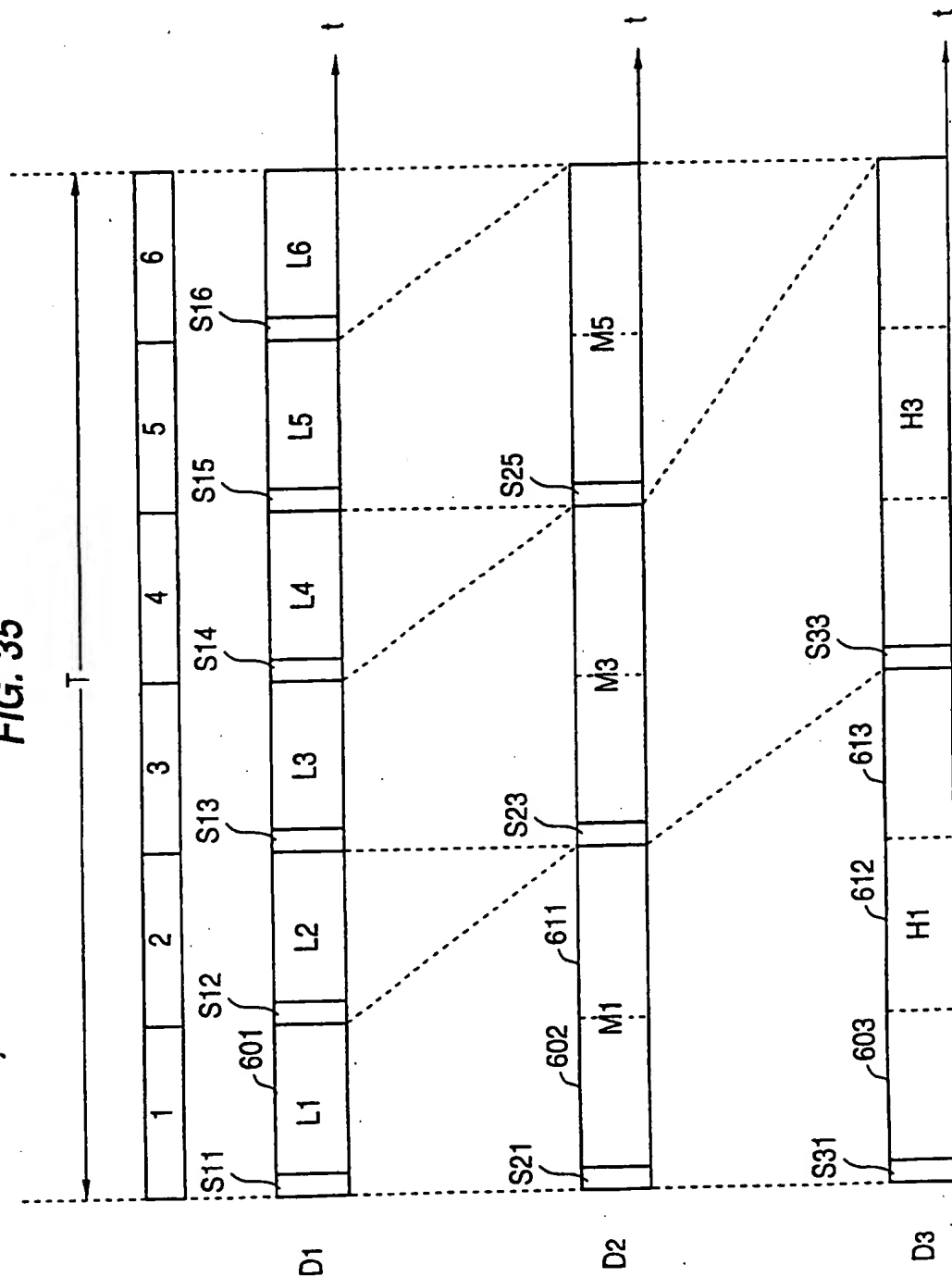


FIG. 36

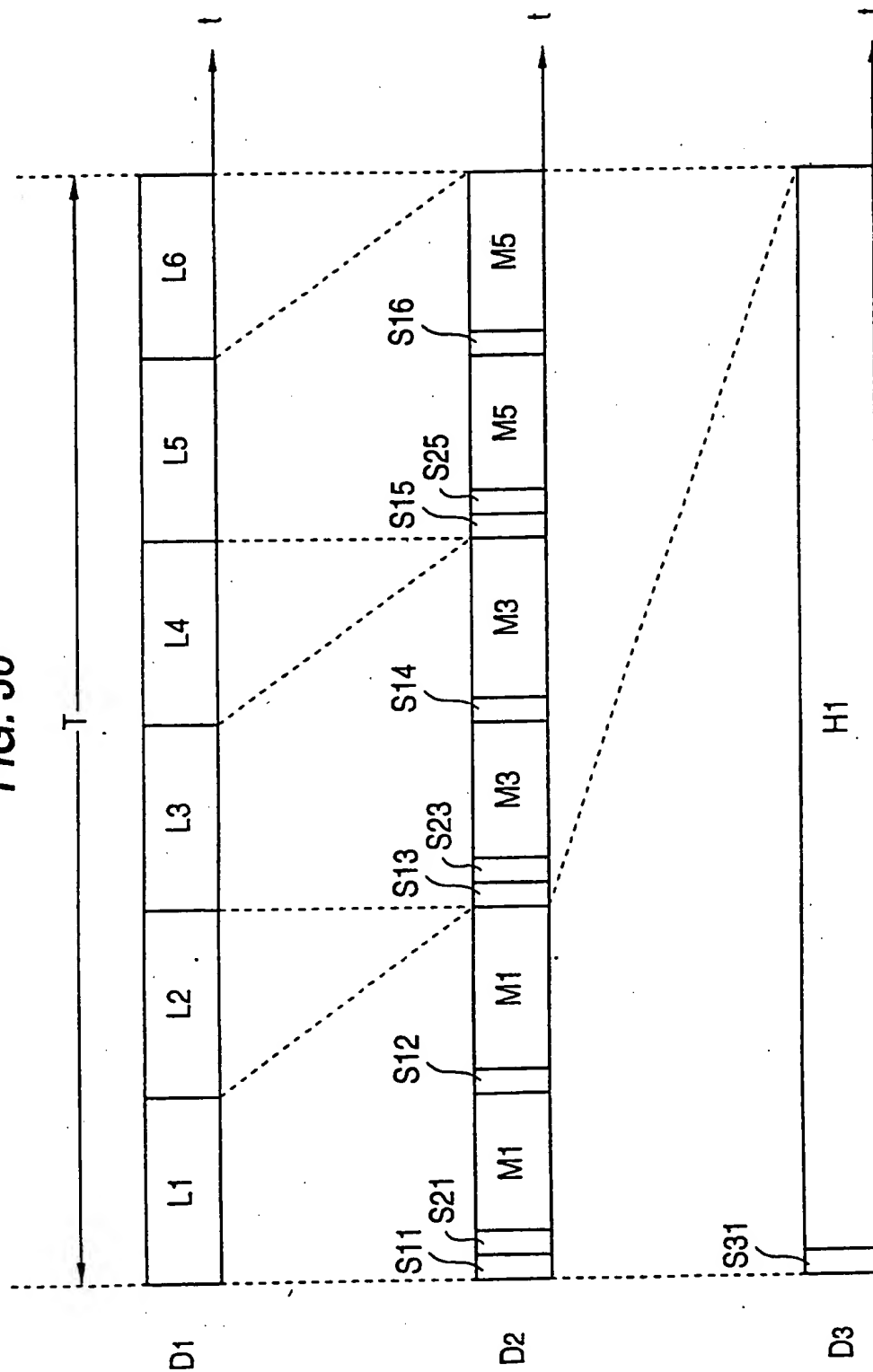


FIG. 37

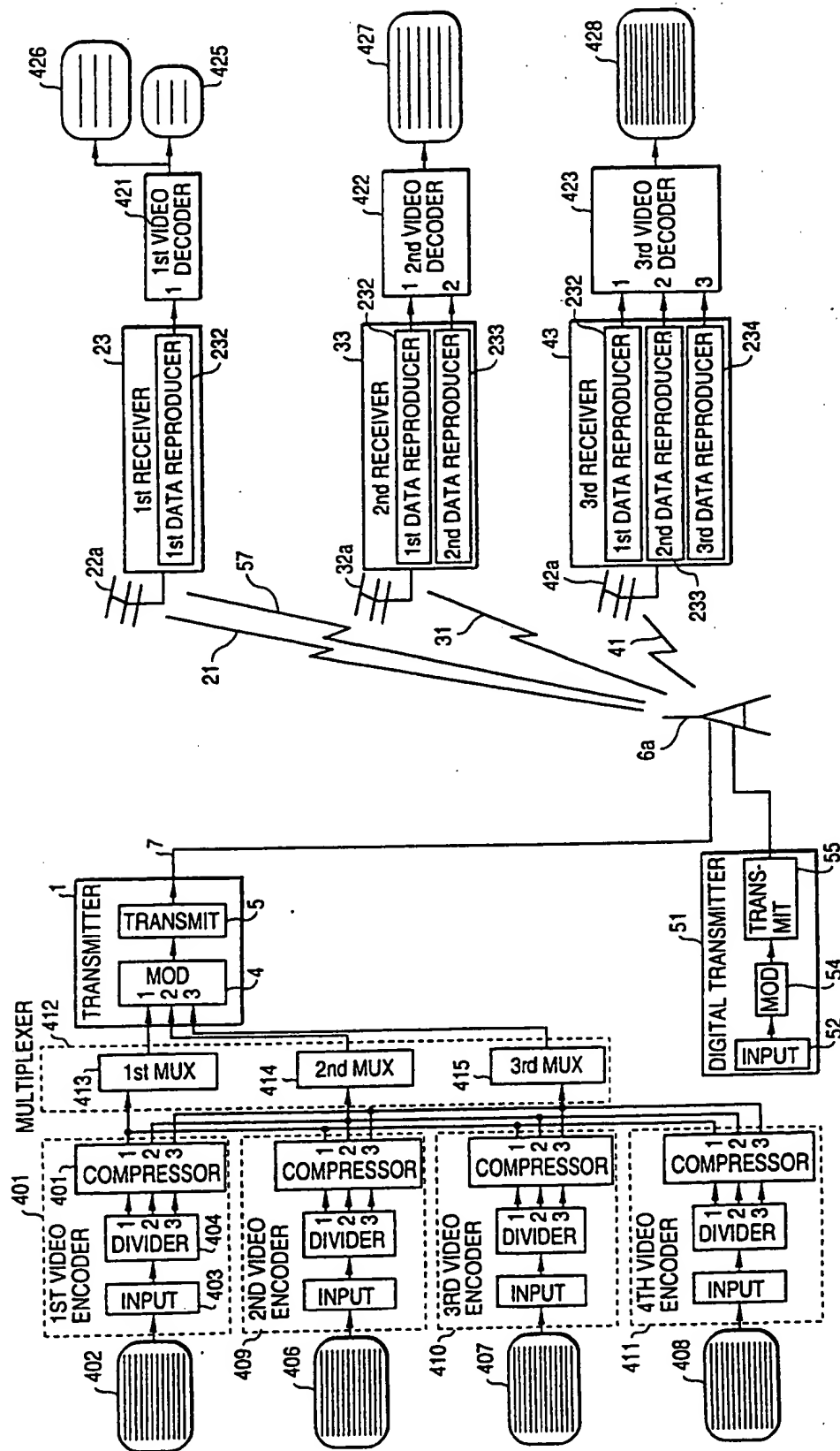


FIG. 38

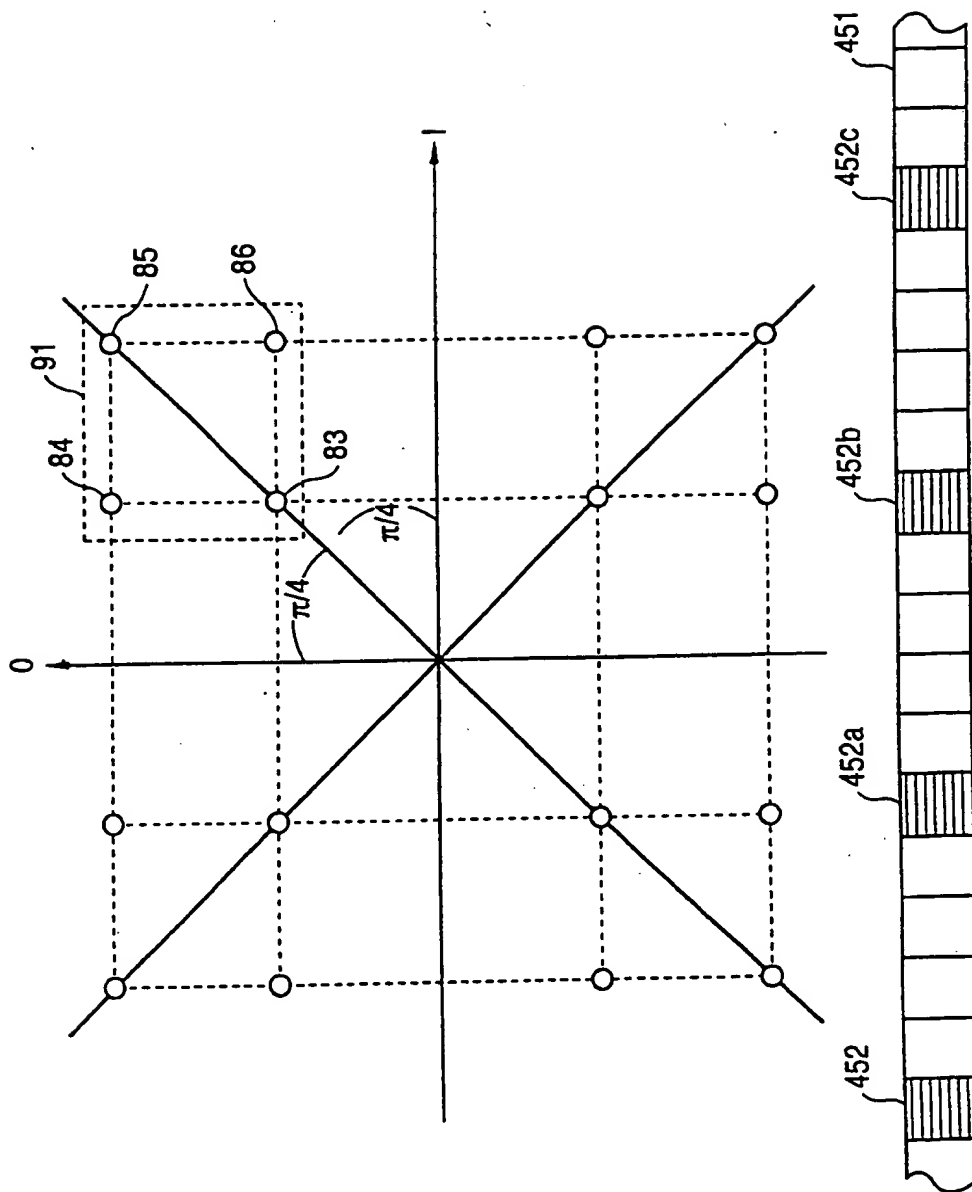


FIG. 39

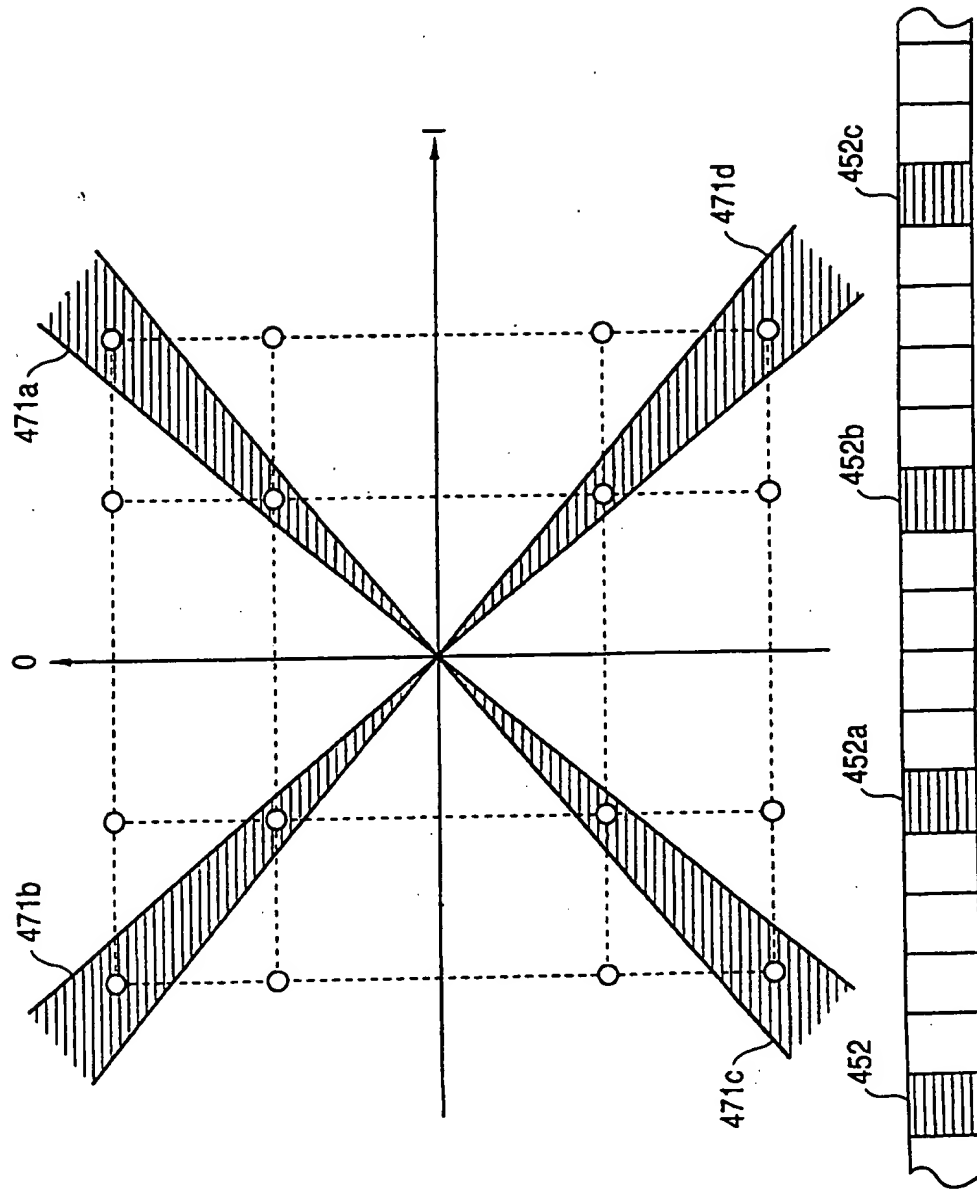
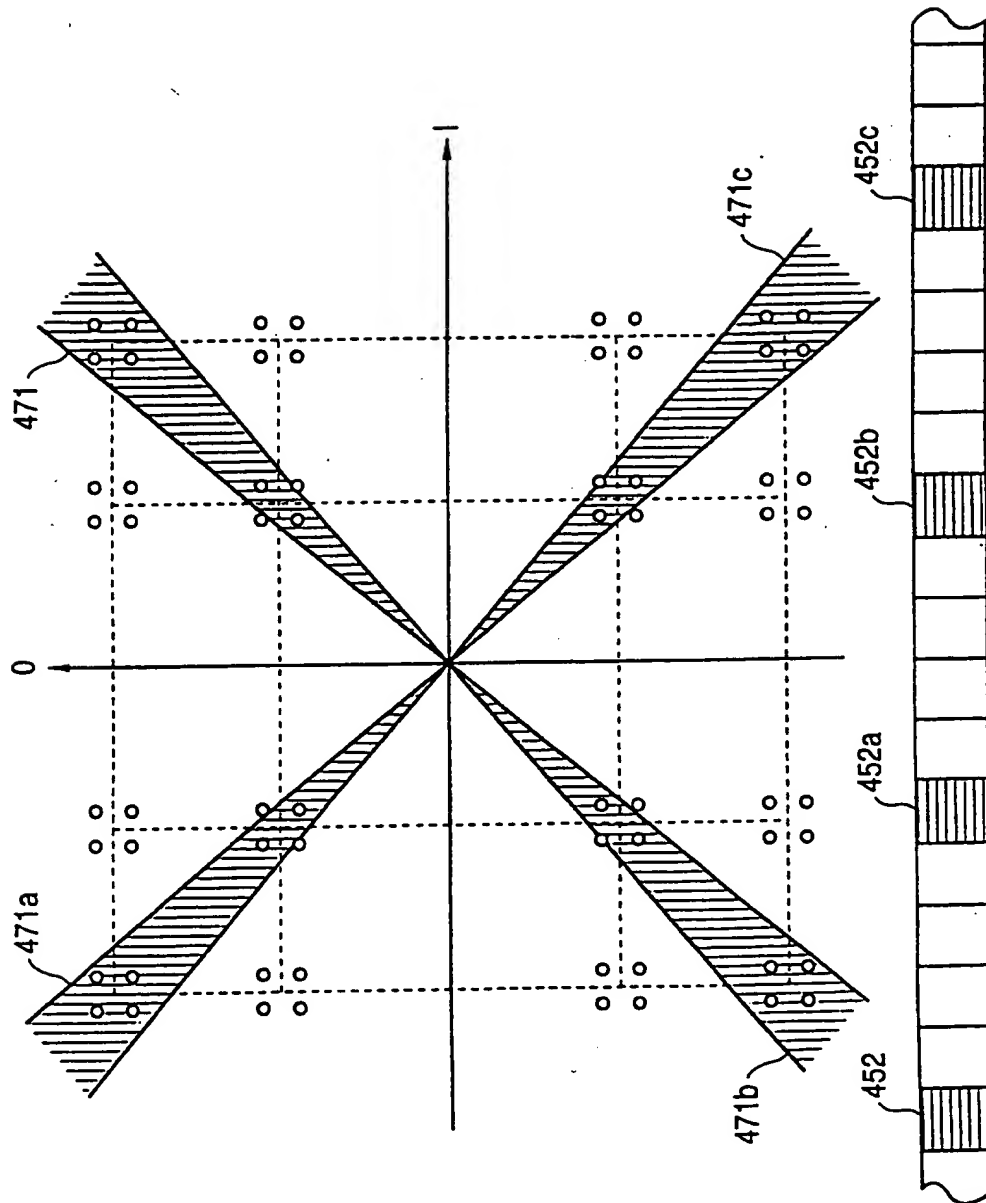


FIG. 40



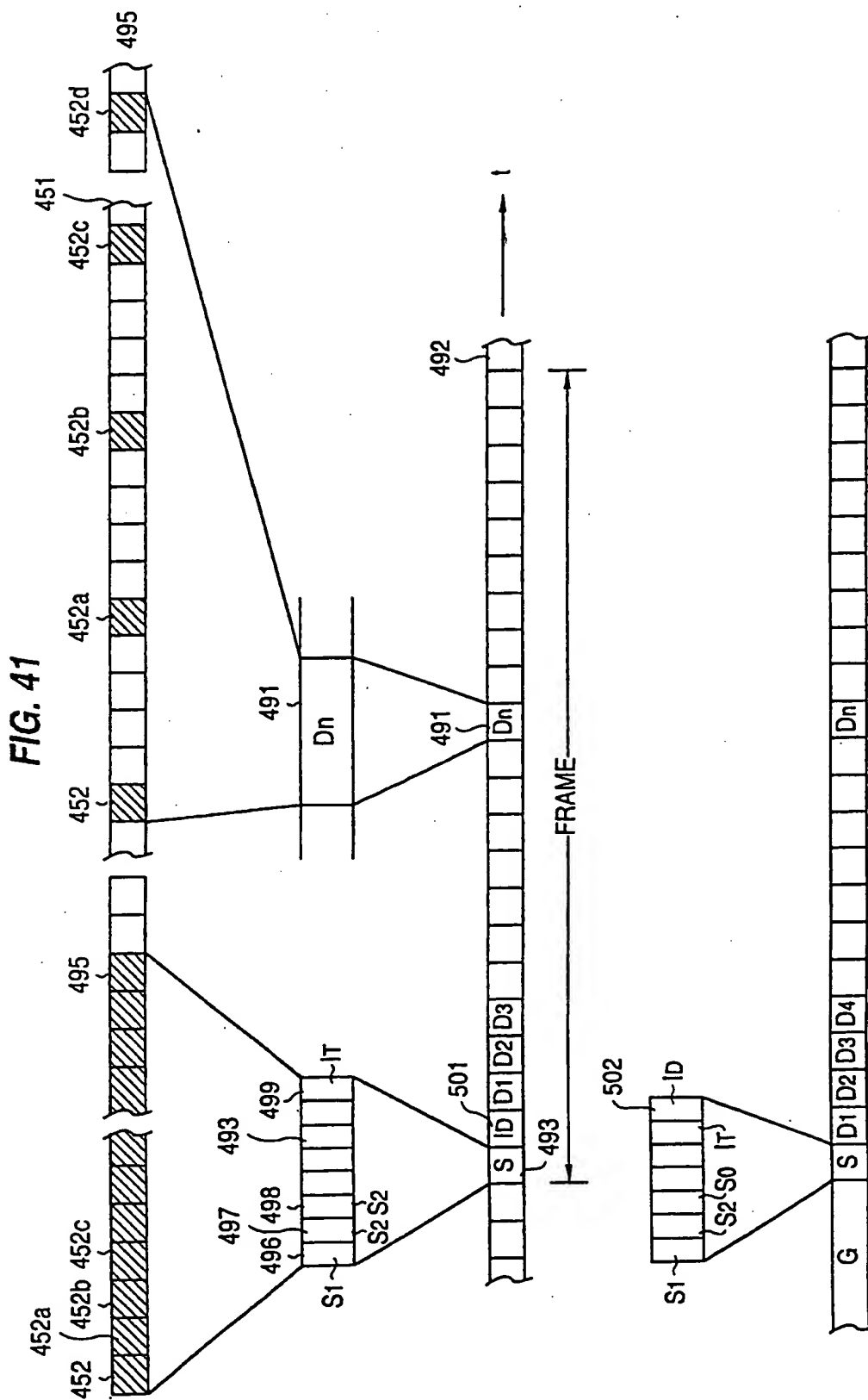


FIG. 42

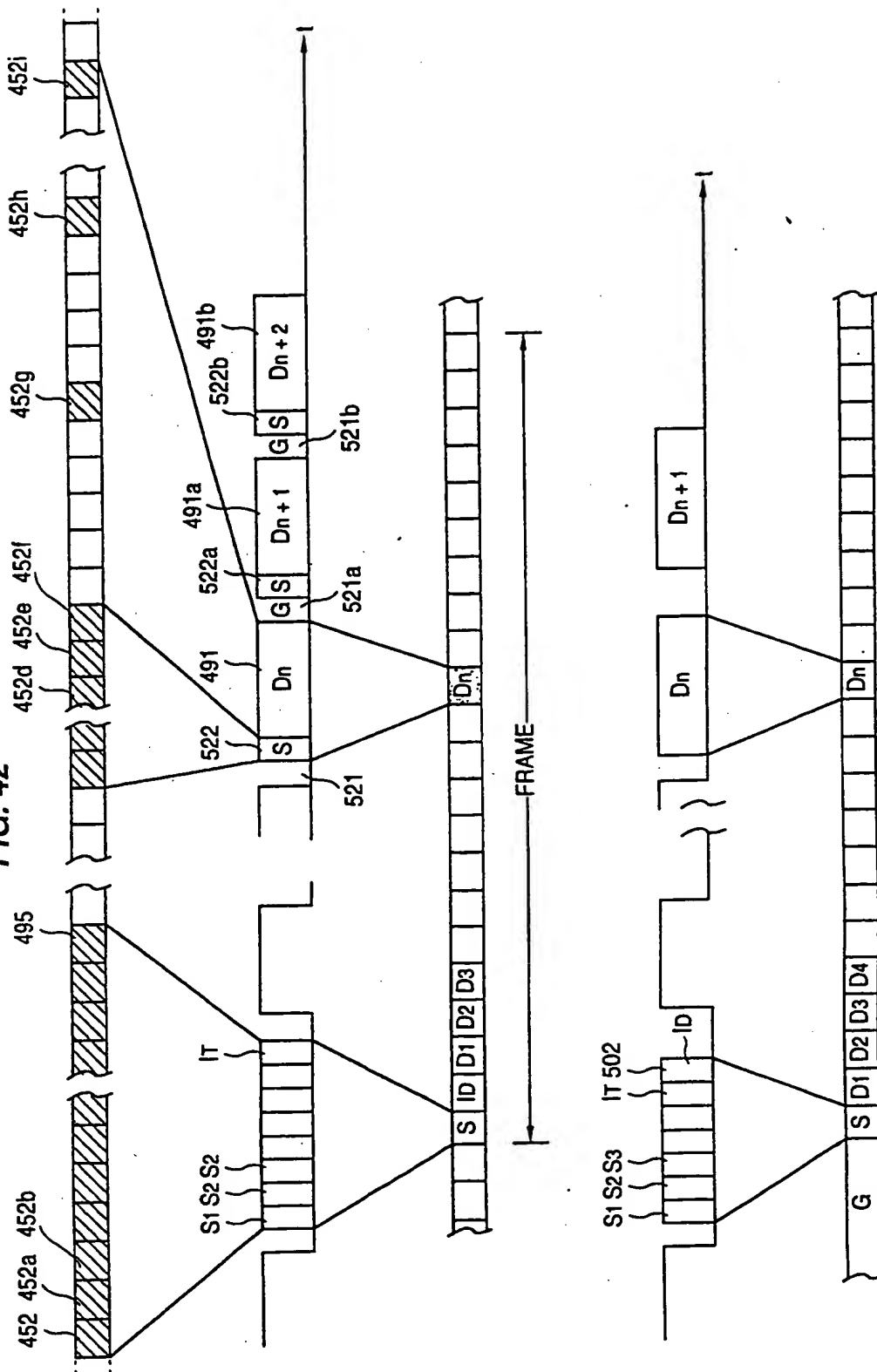


FIG. 43

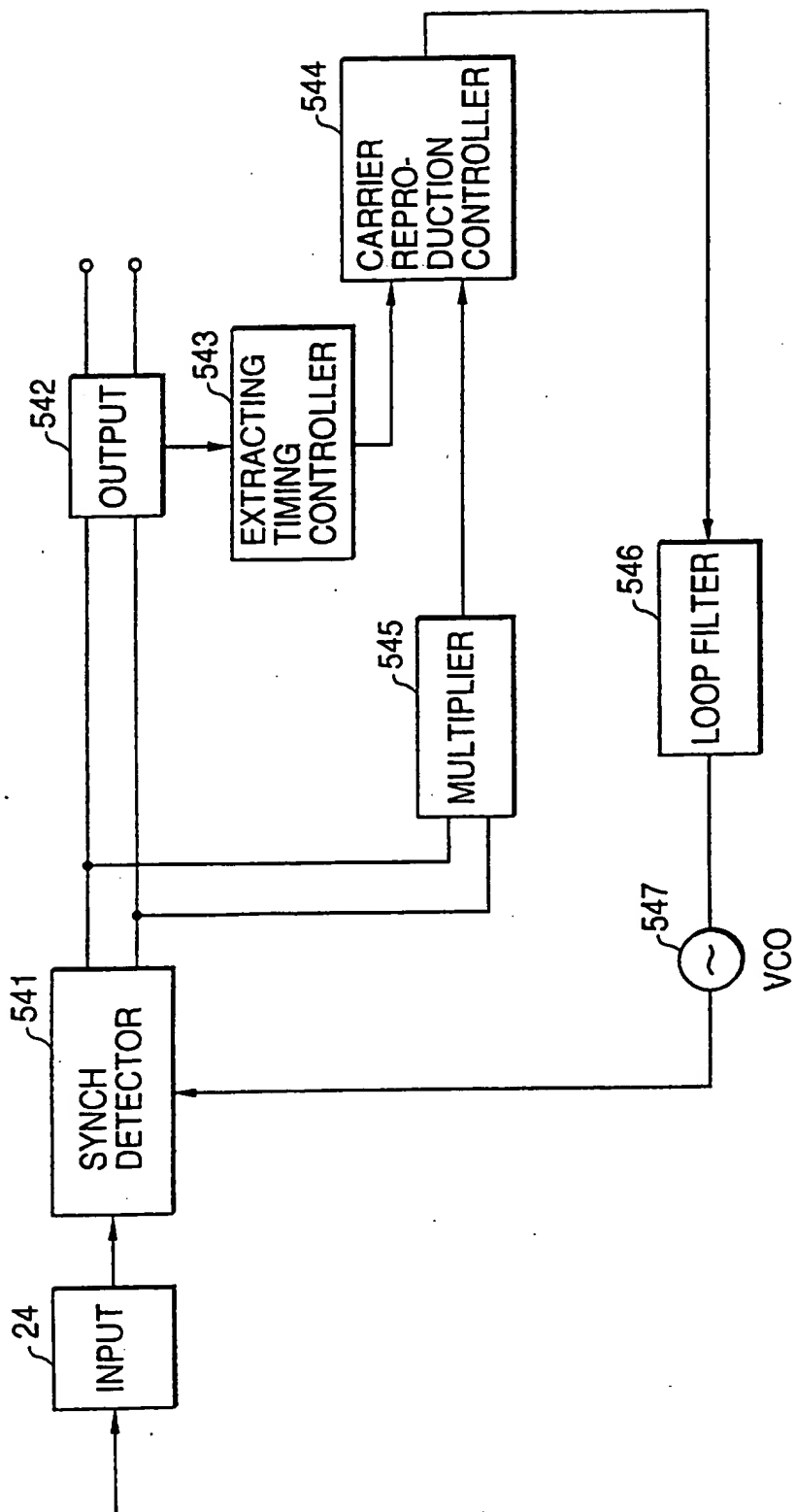


FIG. 44

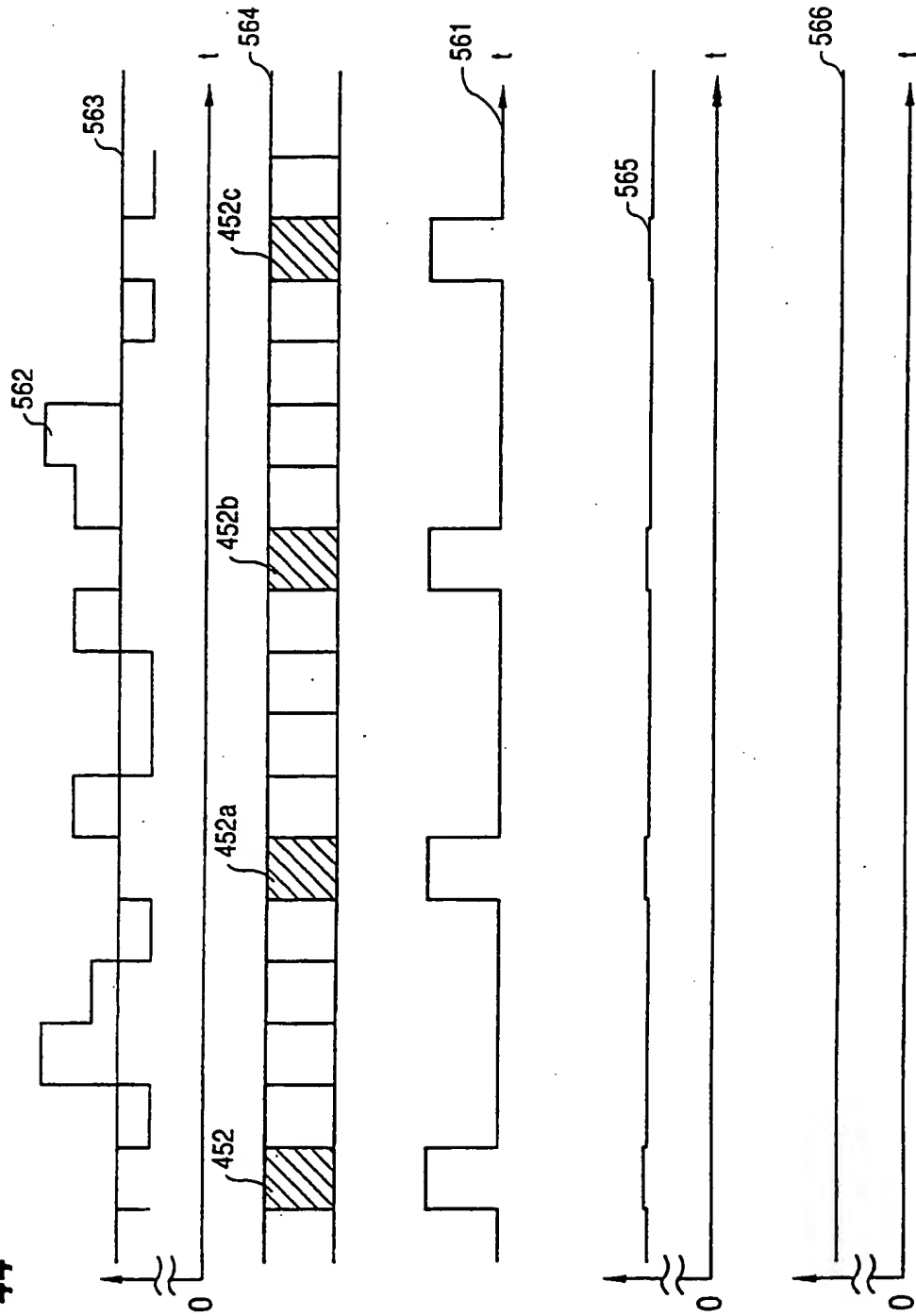


FIG. 45

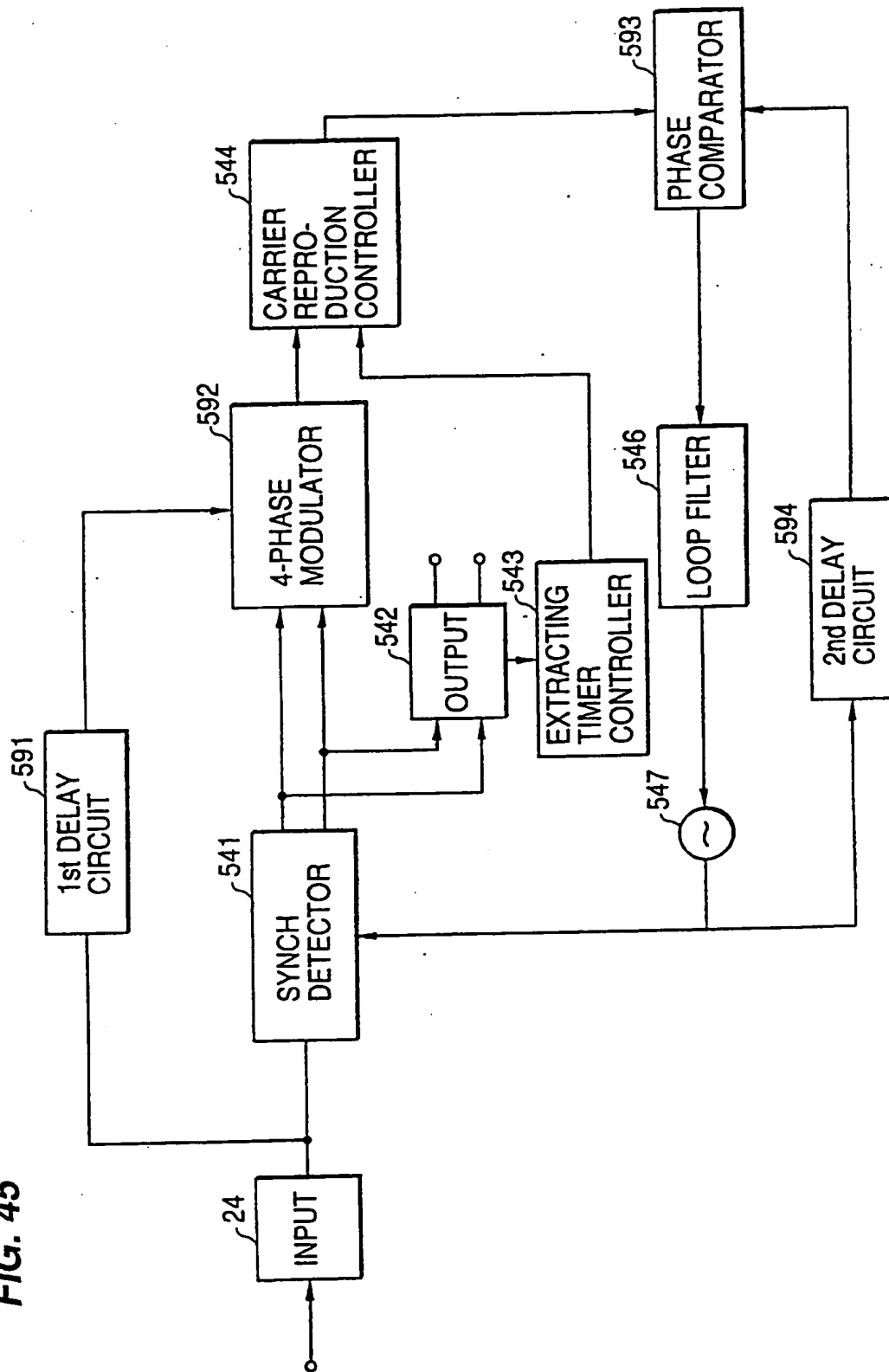


FIG. 46

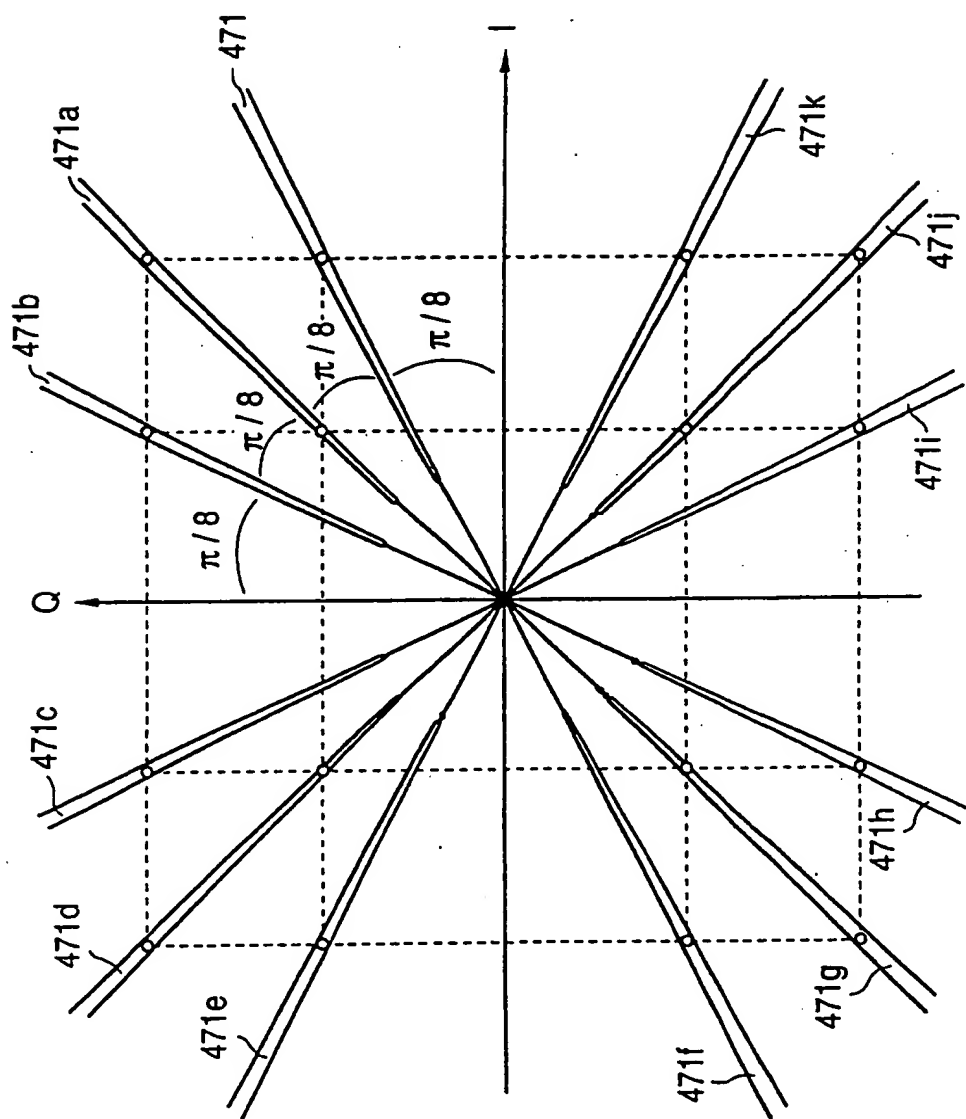


FIG. 47

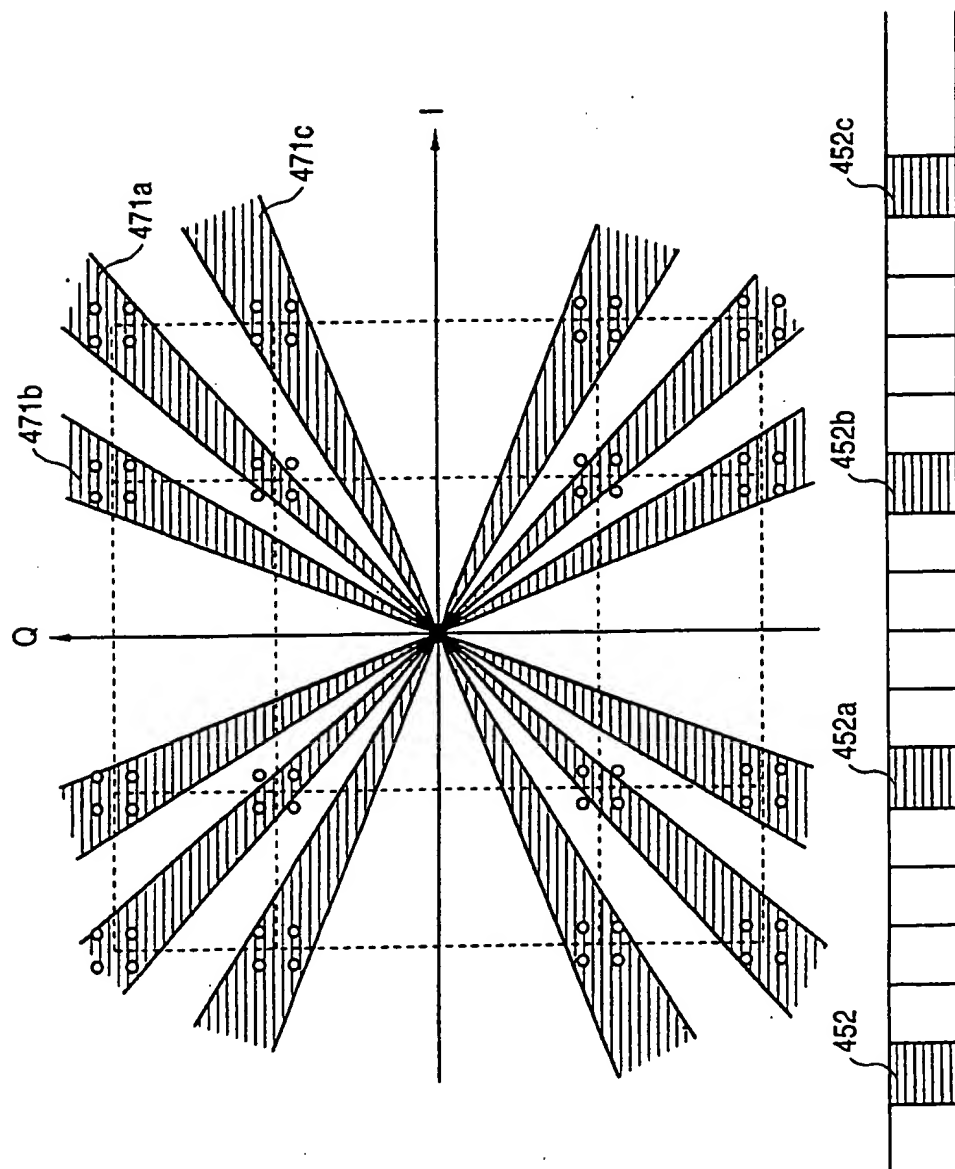


FIG. 48

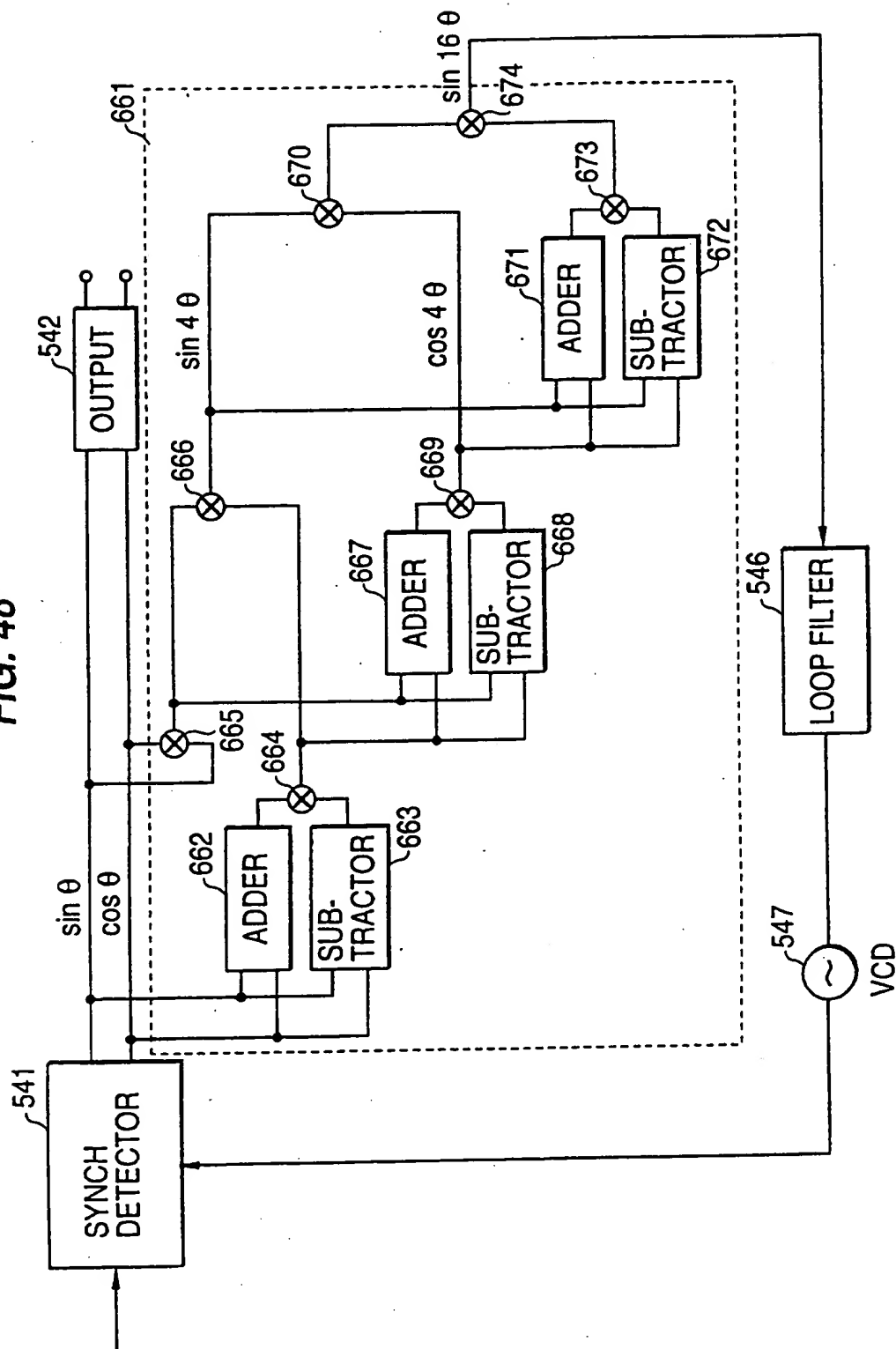


FIG. 49

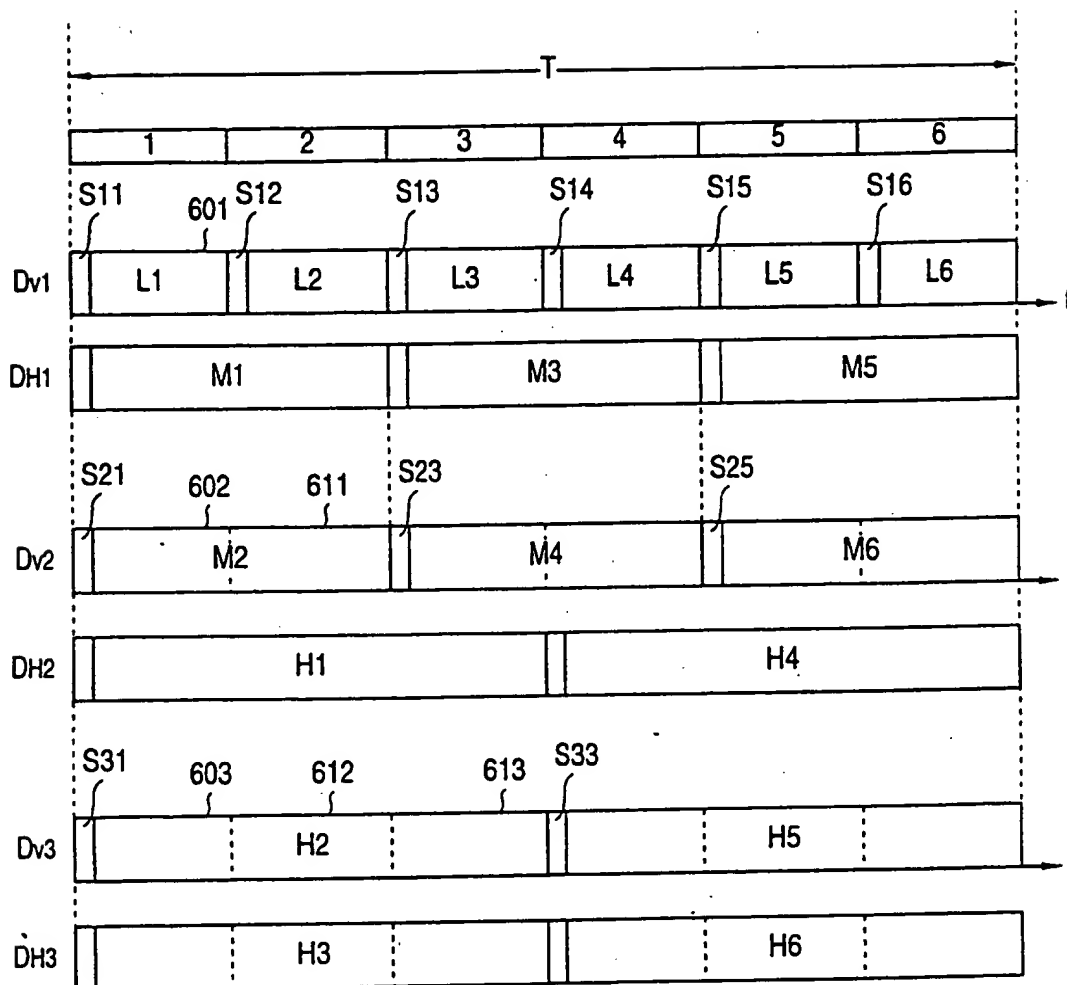


FIG. 50

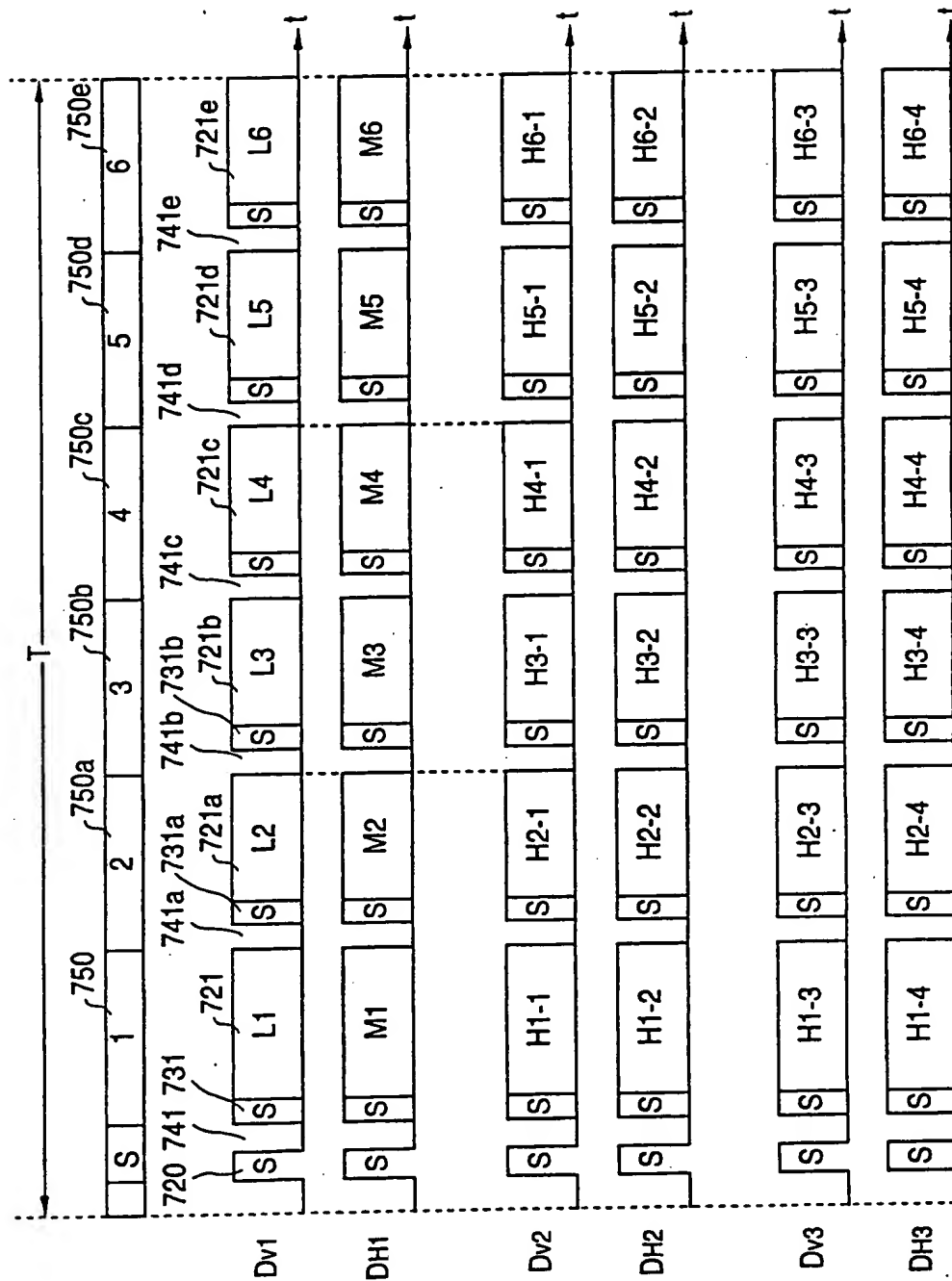


FIG. 51

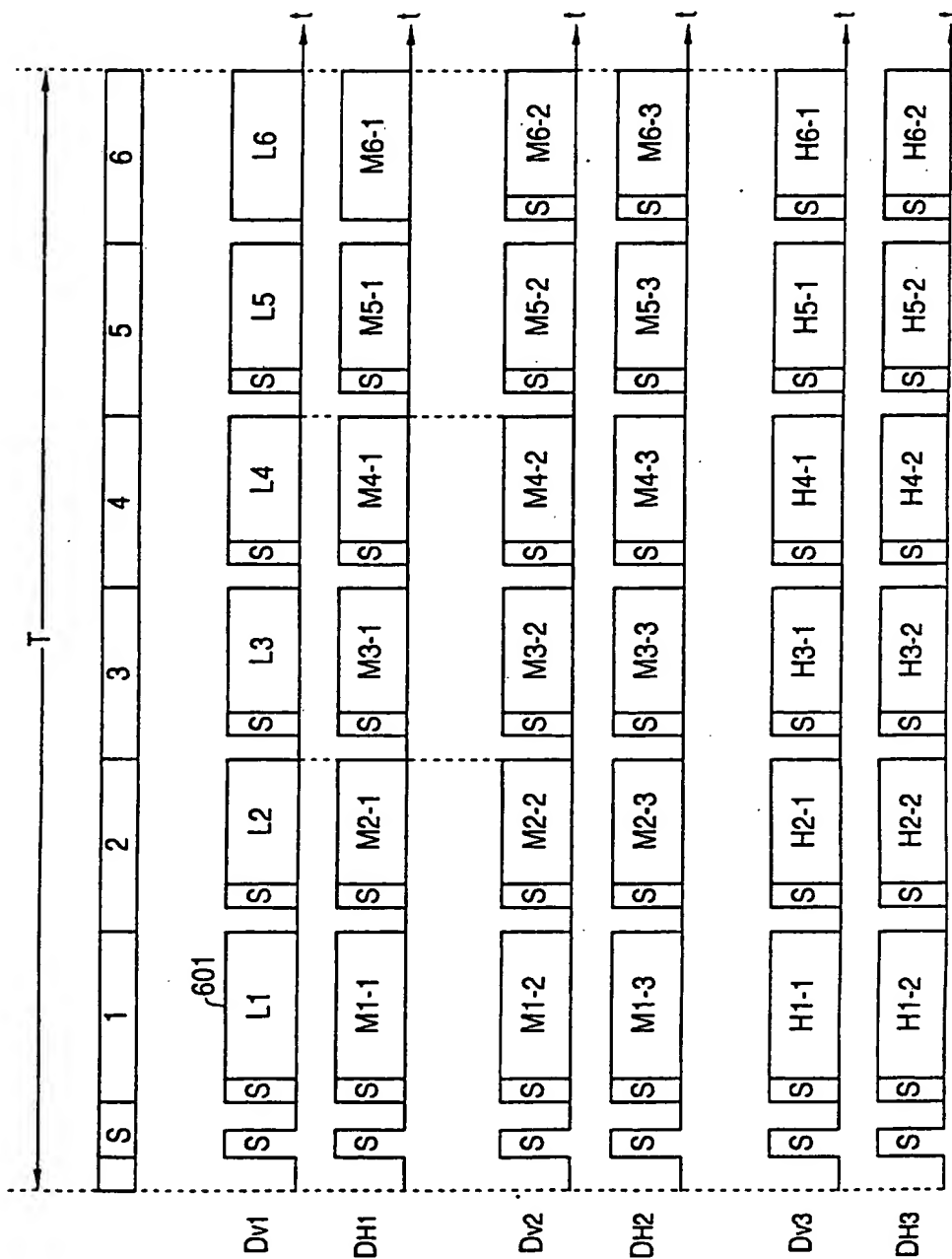


FIG. 52

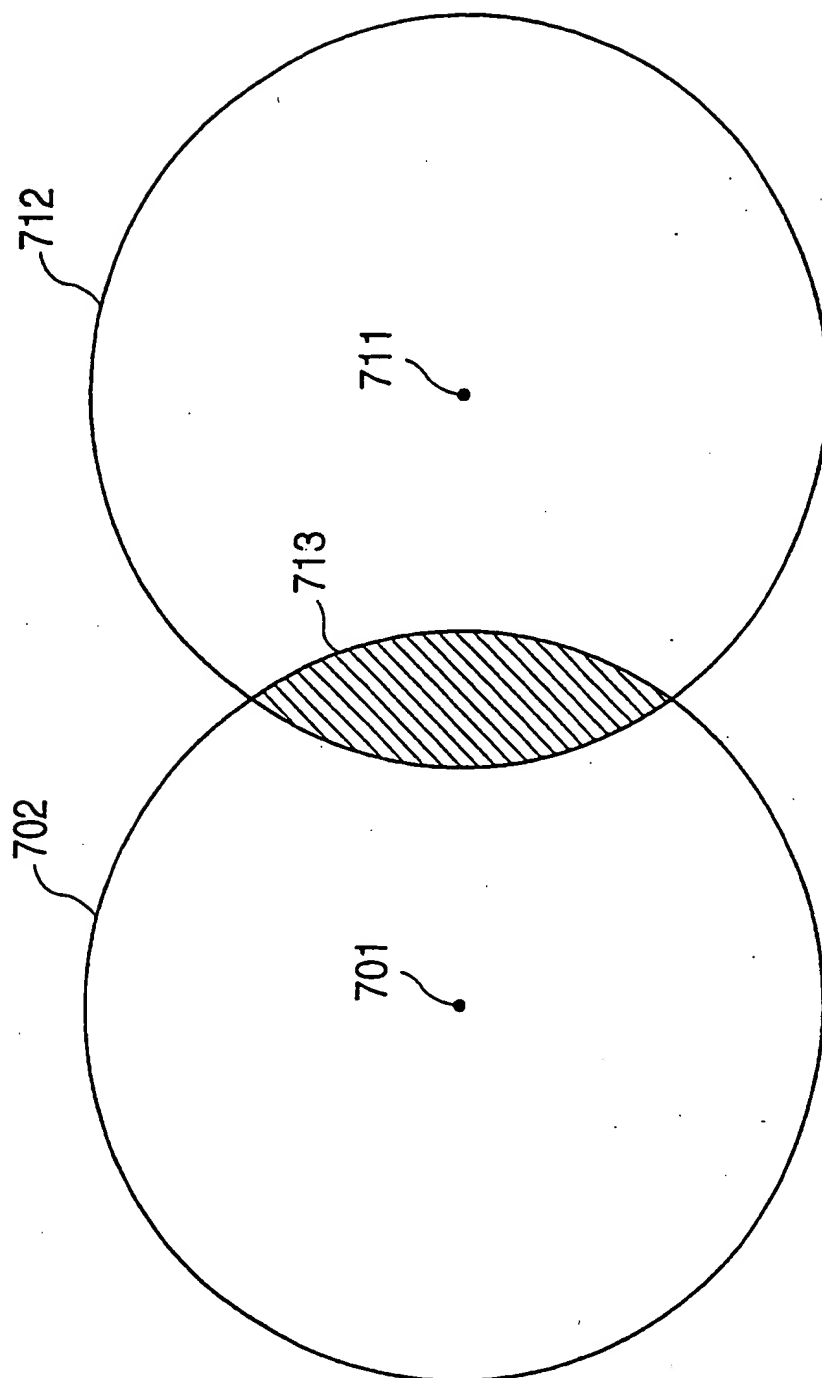


FIG. 53

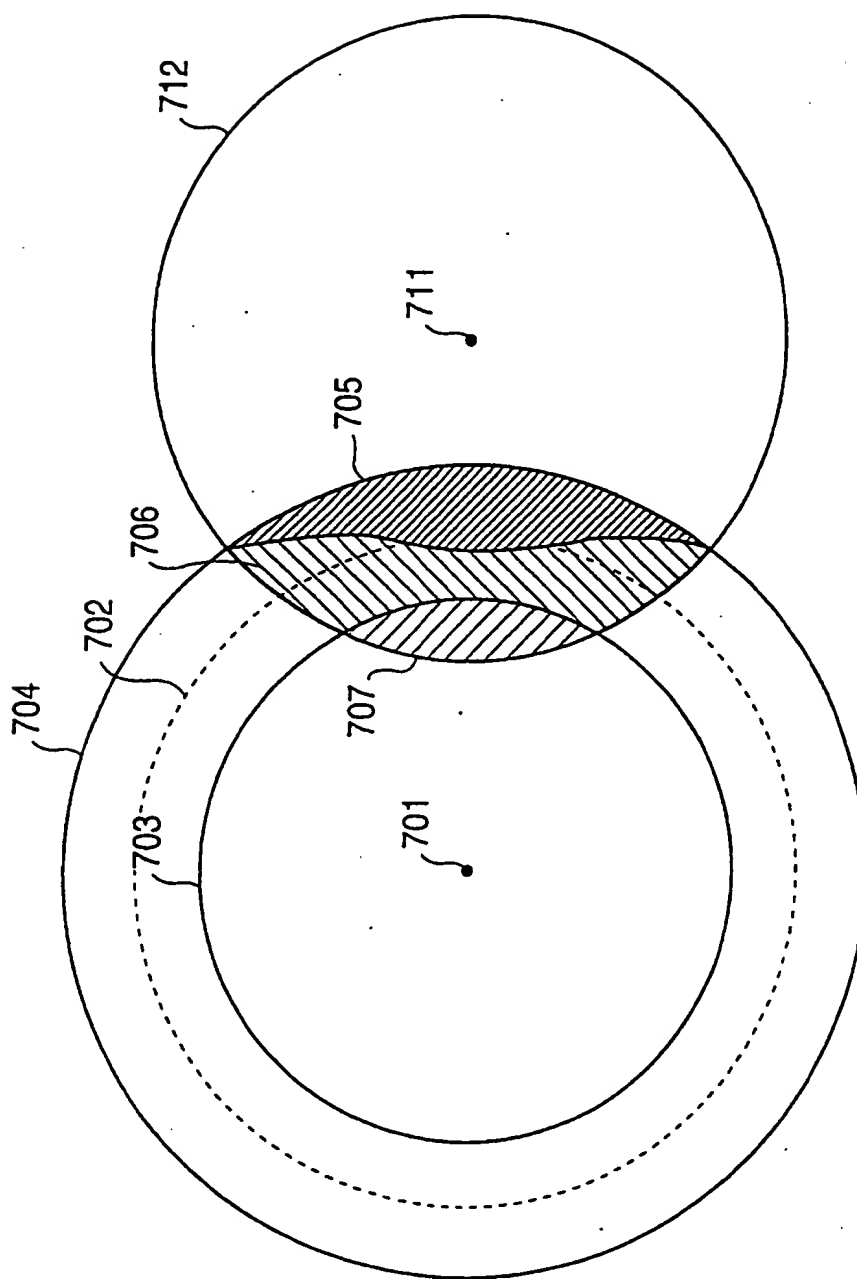
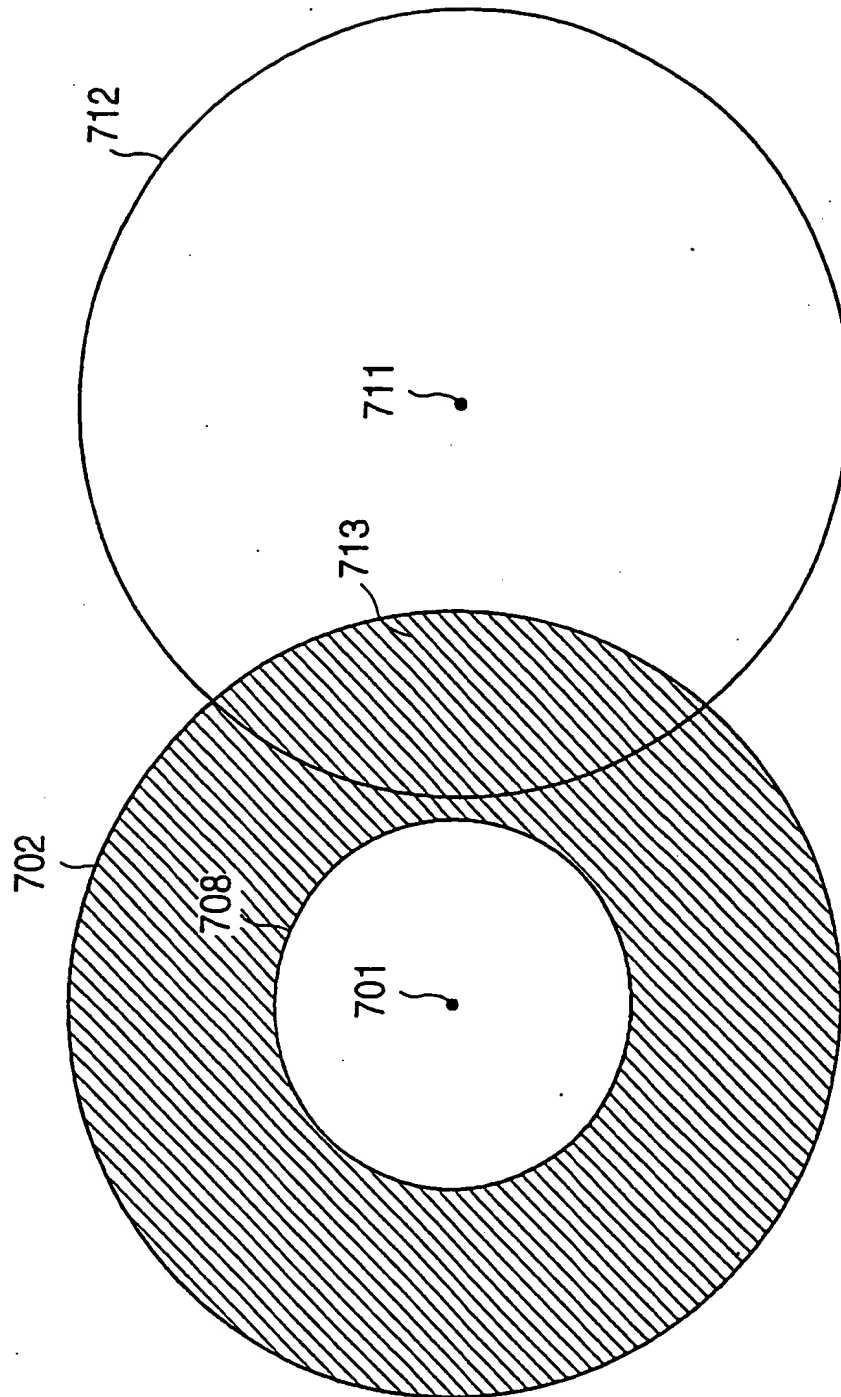
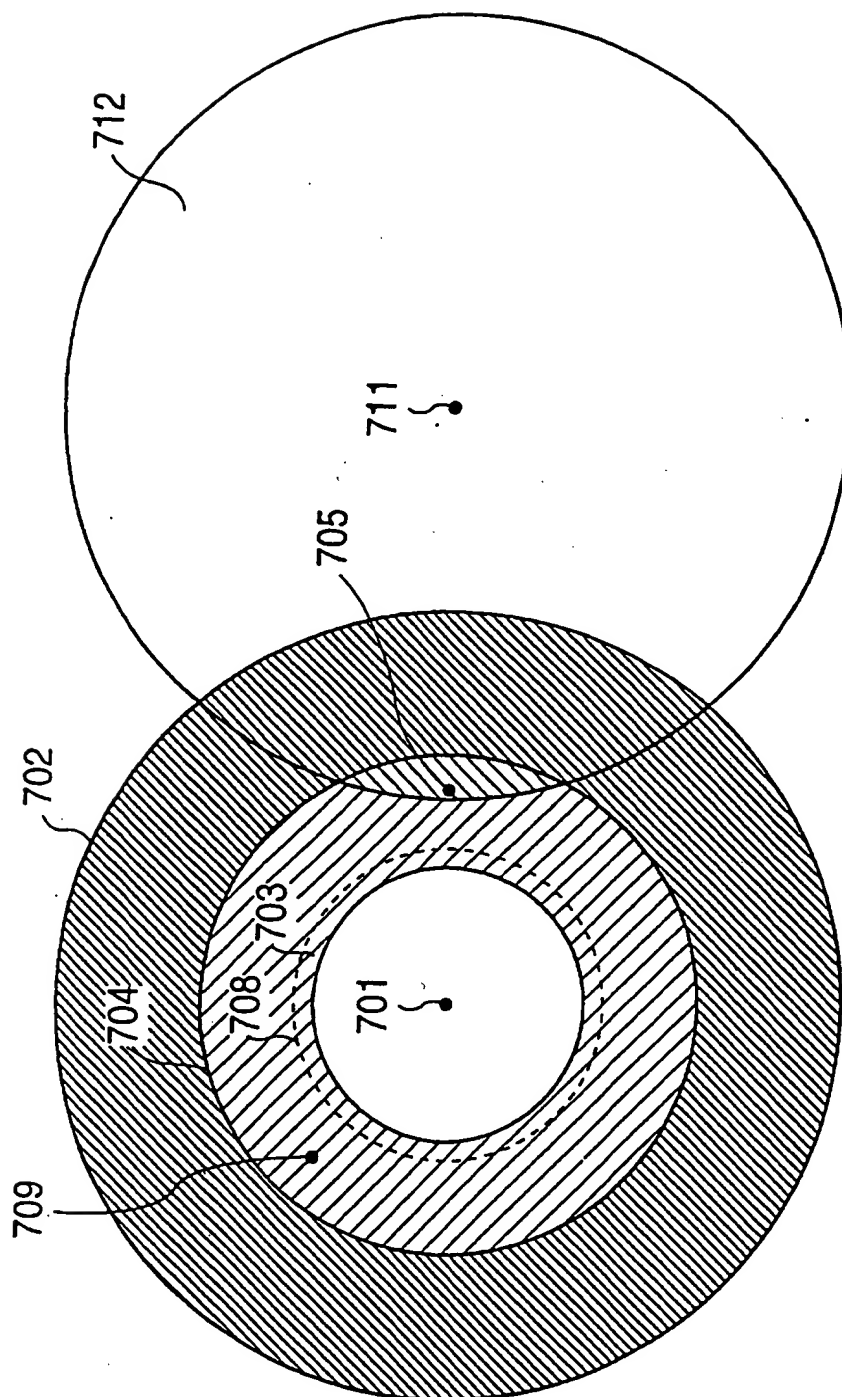


FIG. 54



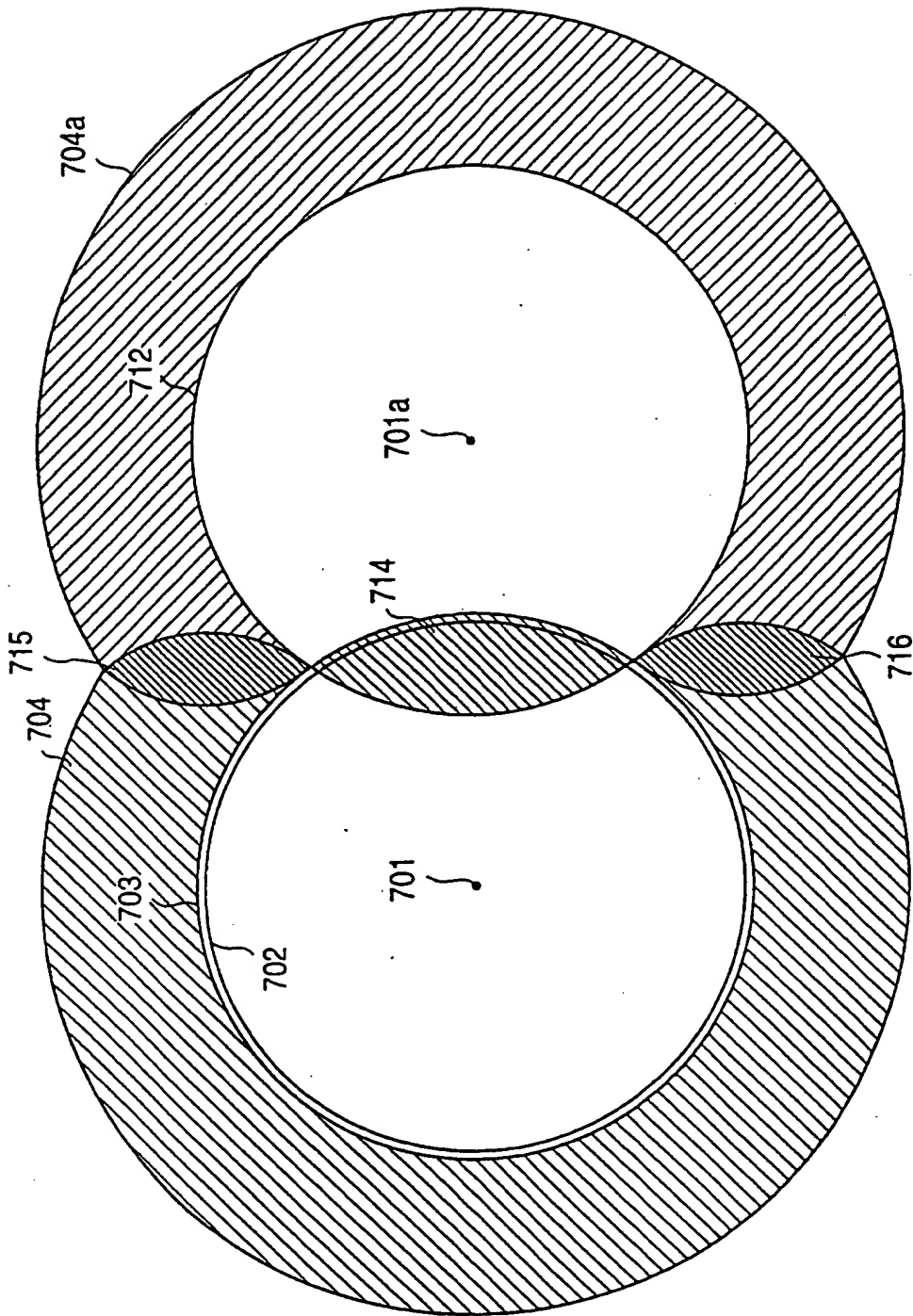
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FIG. 55



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FIG. 56



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FIG. 57

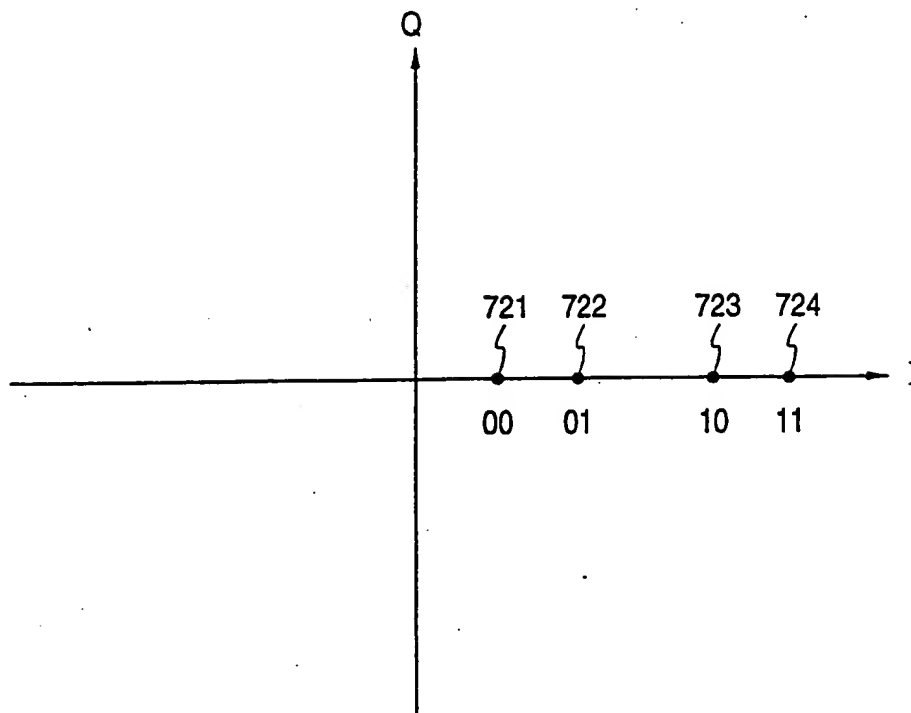
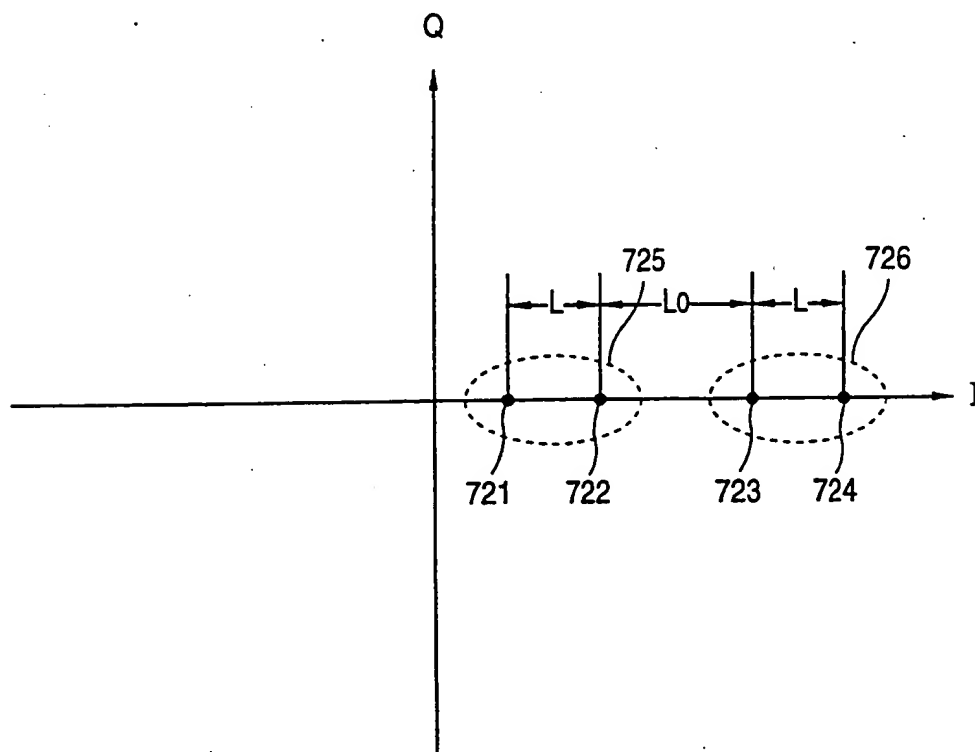


FIG. 58



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FIG. 59(a)

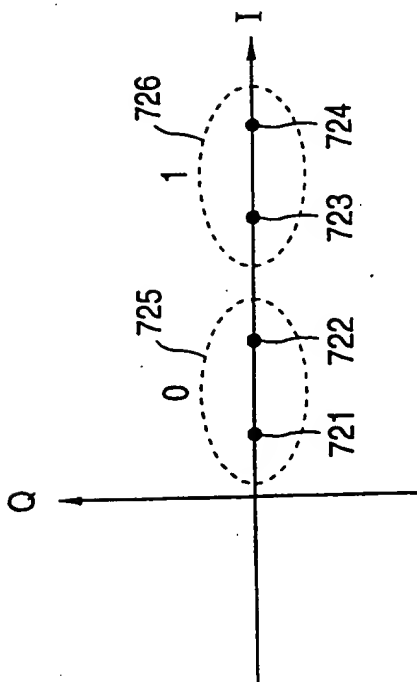


FIG. 59(c)

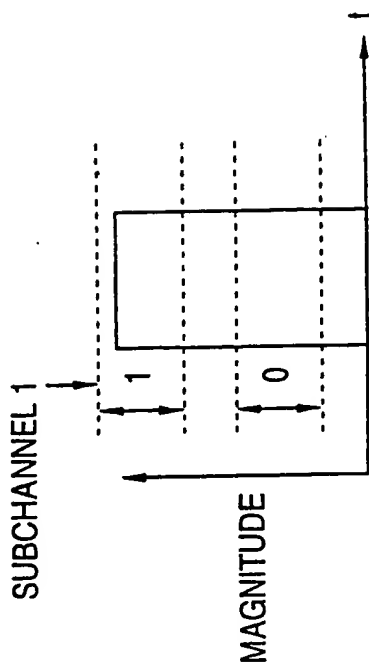


FIG. 59(b)

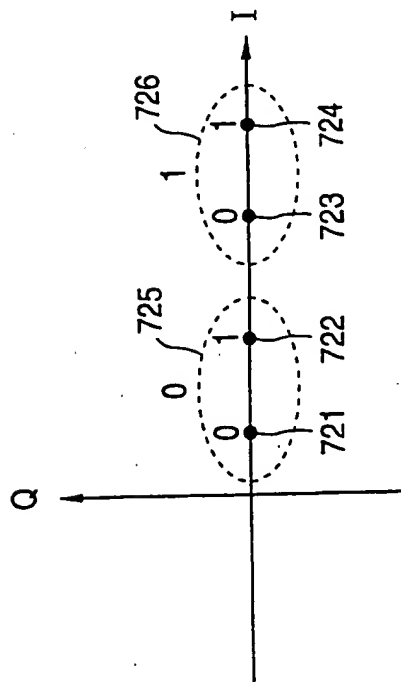


FIG. 59(d)

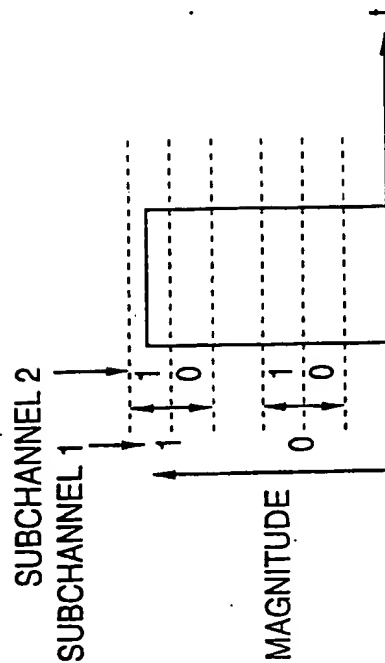


FIG. 60

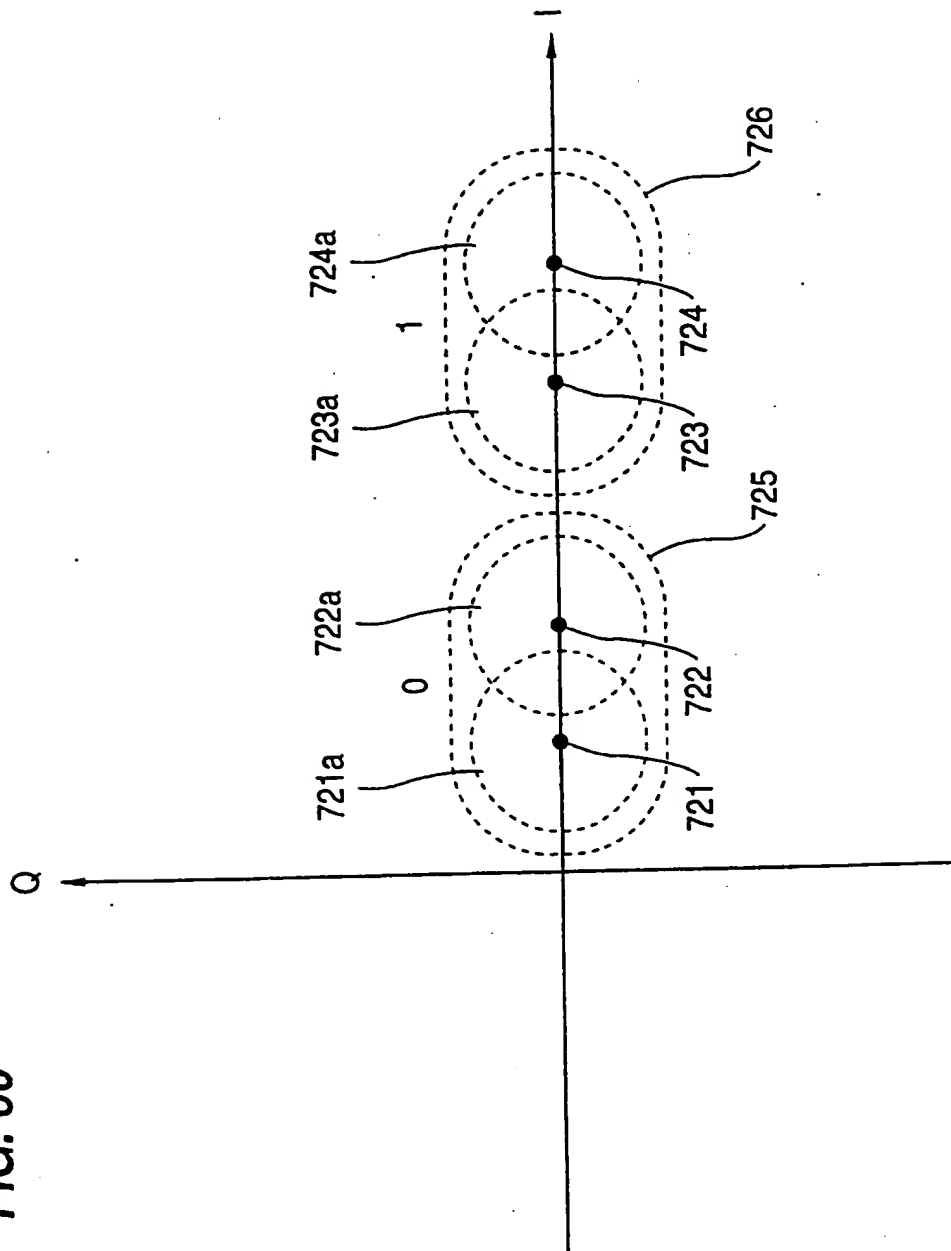


FIG. 61

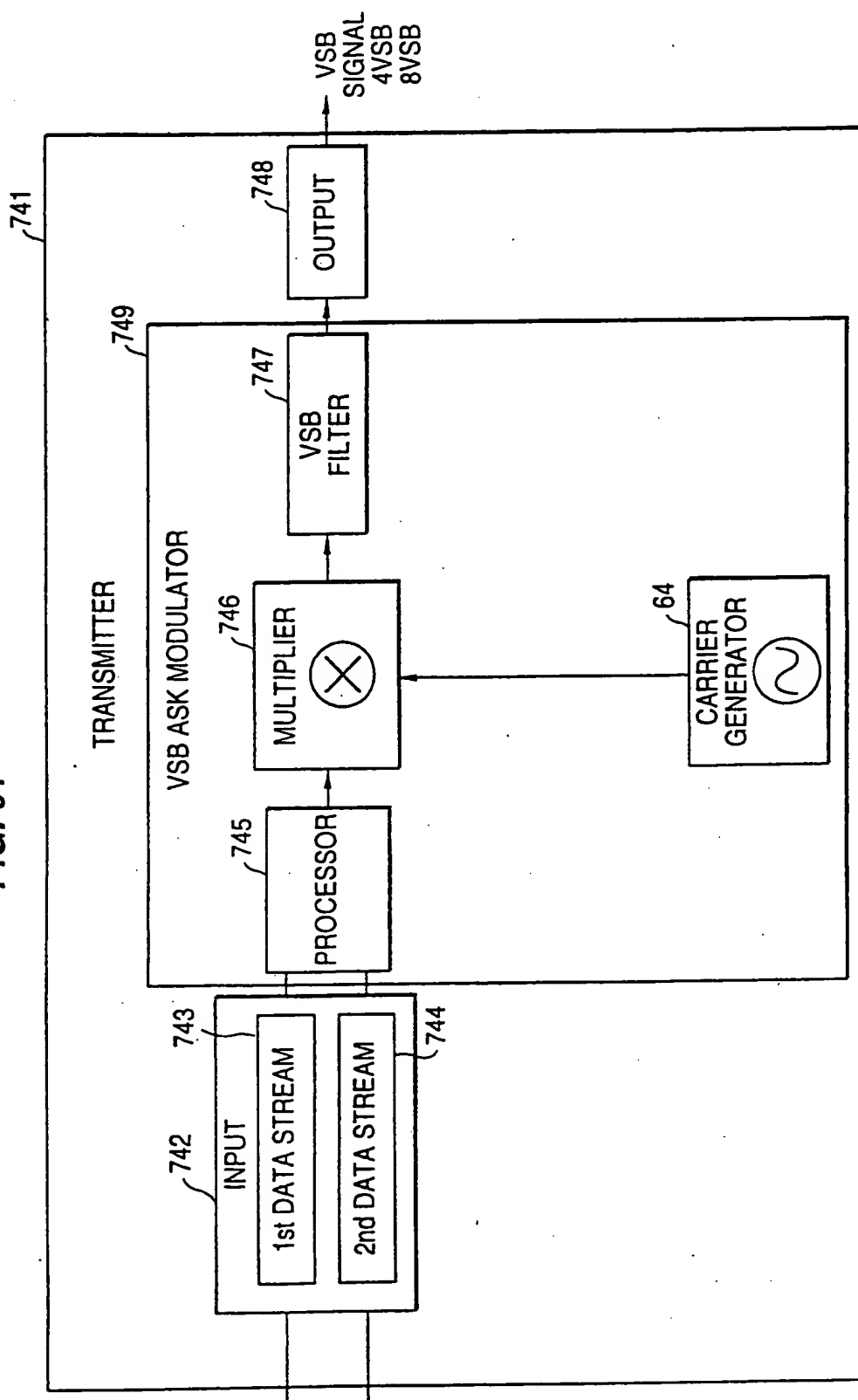


FIG. 62(a)

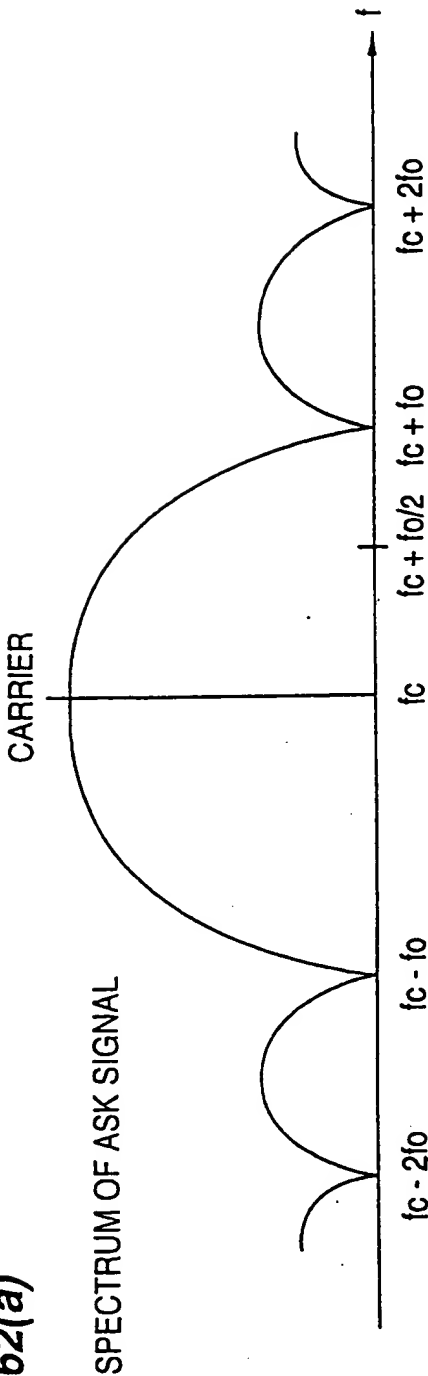
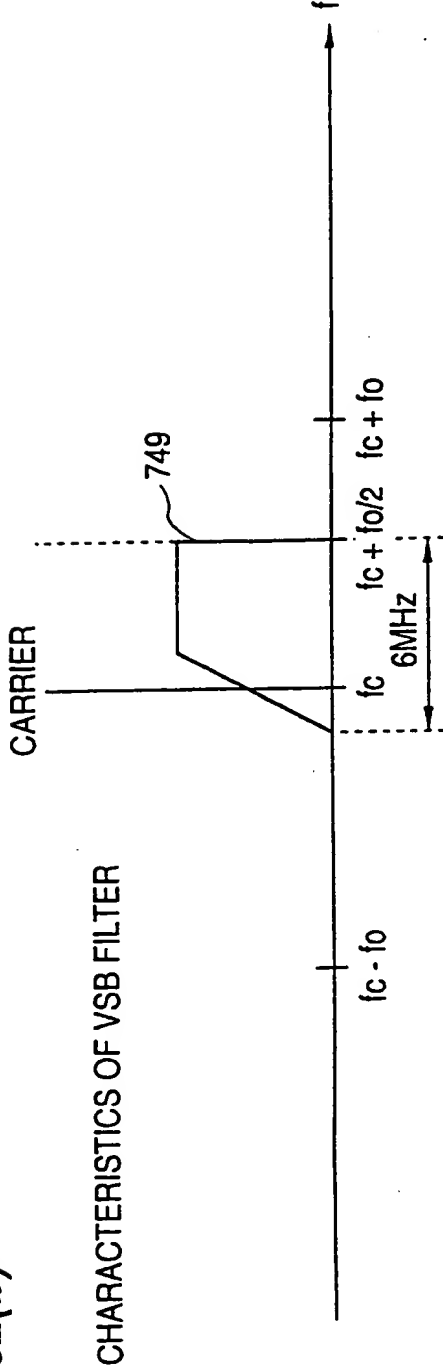


FIG. 62(b)



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FIG. 63

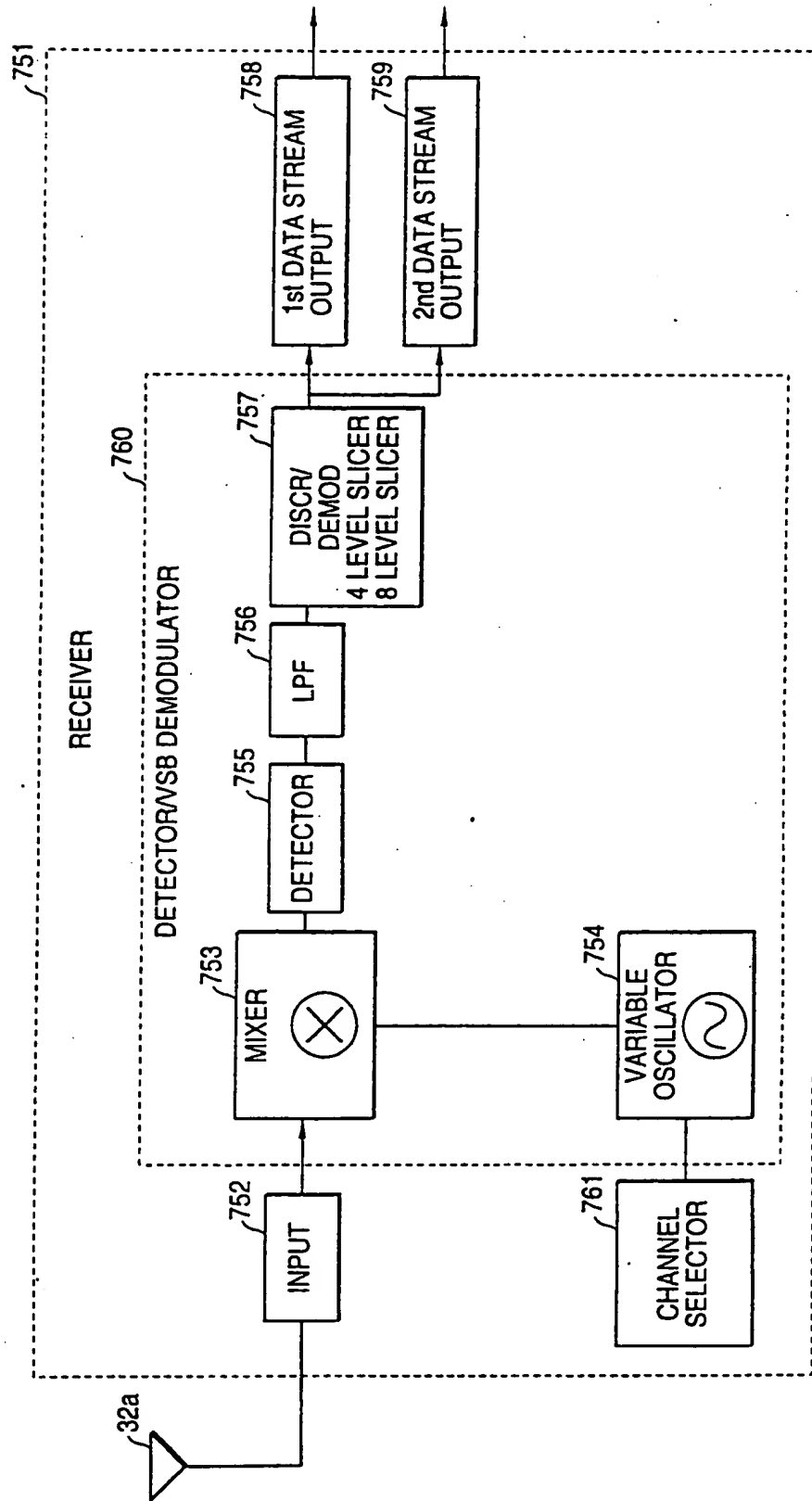
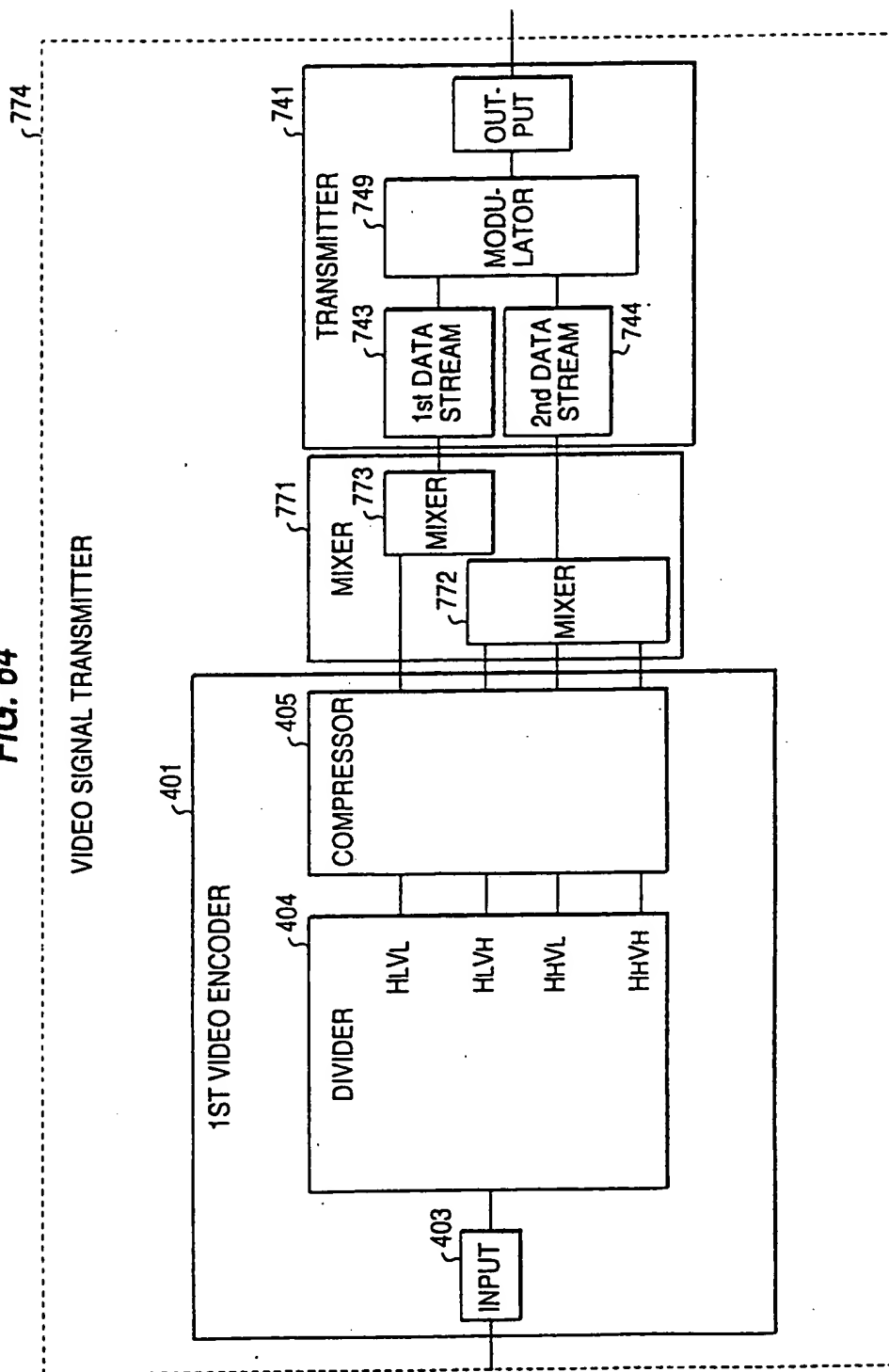


FIG. 64



[illegible]

FIG. 65

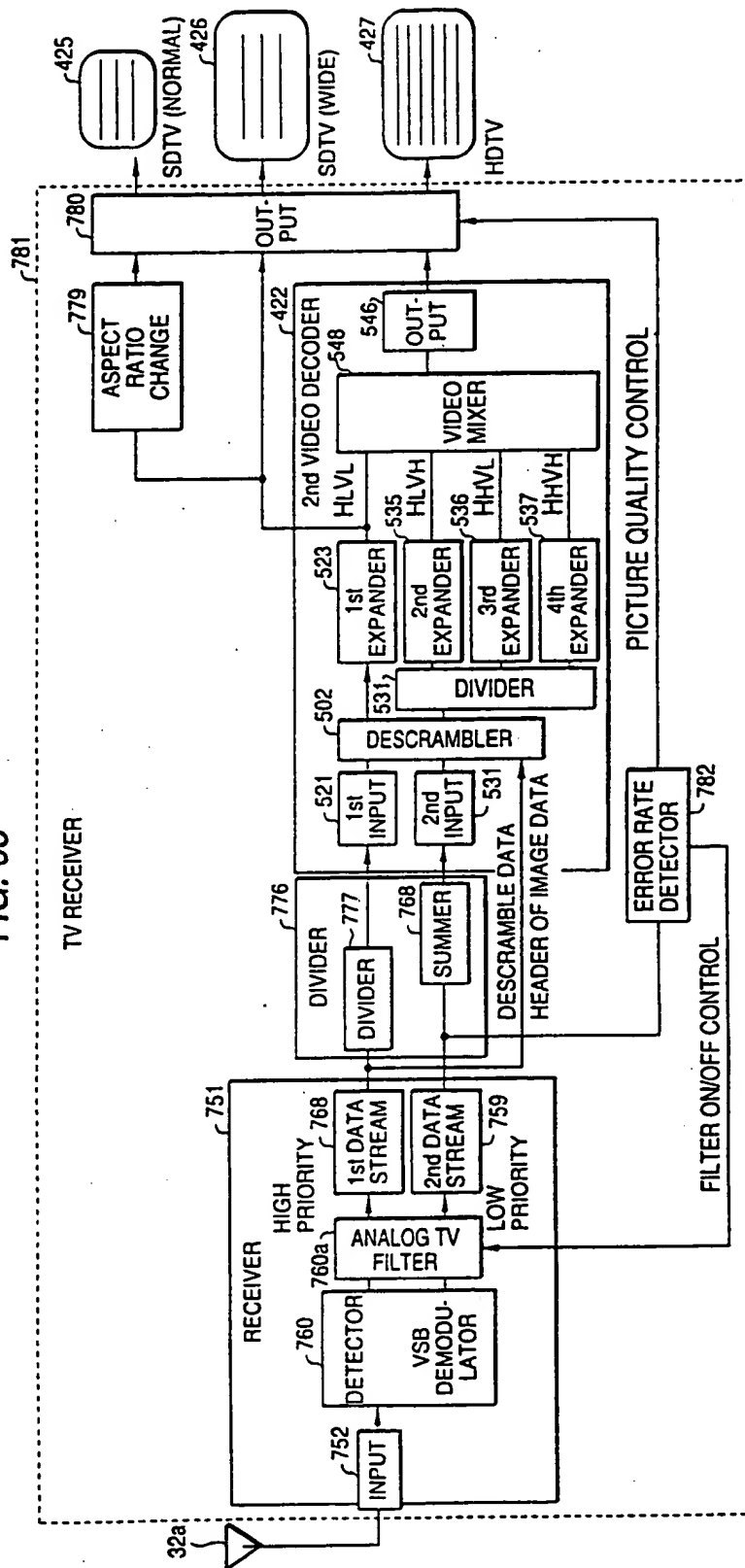


FIG. 66

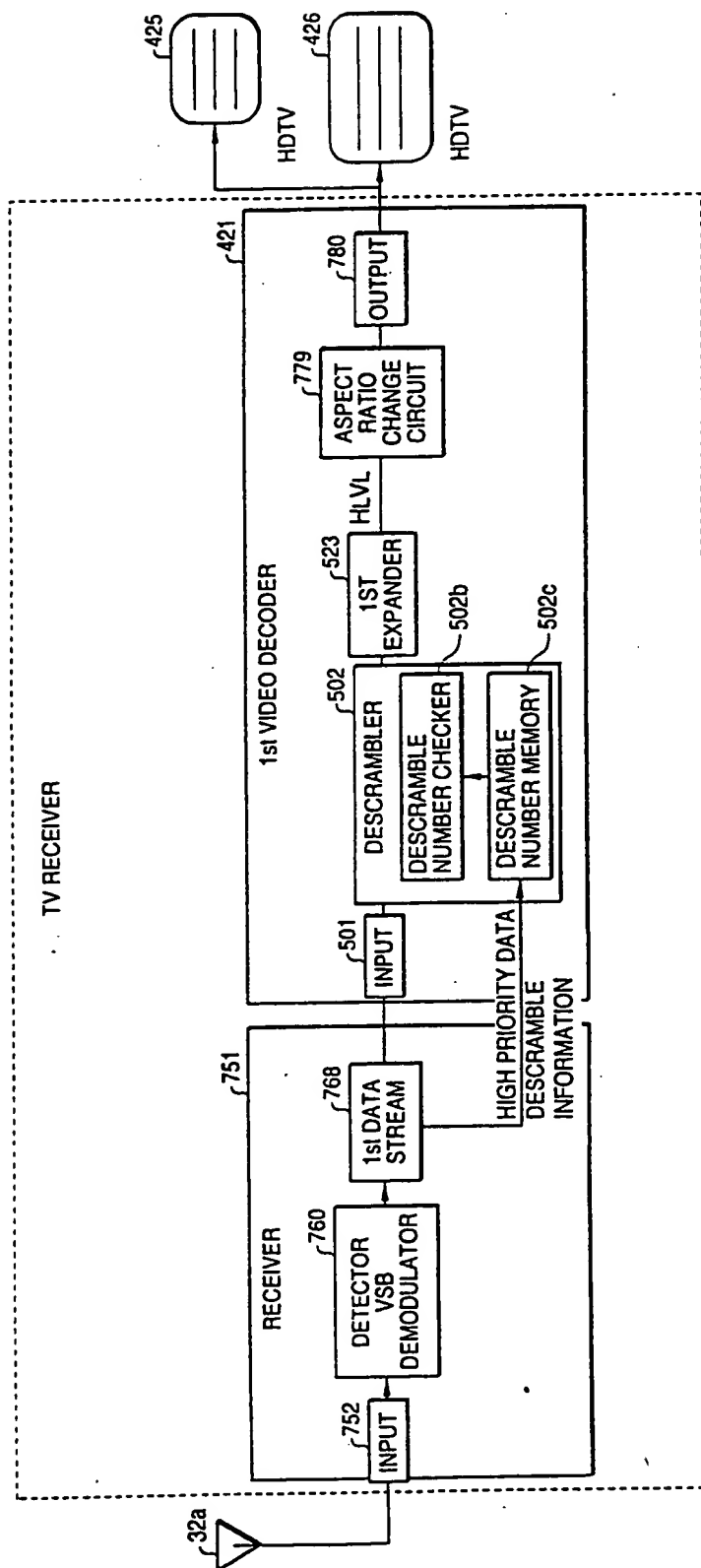
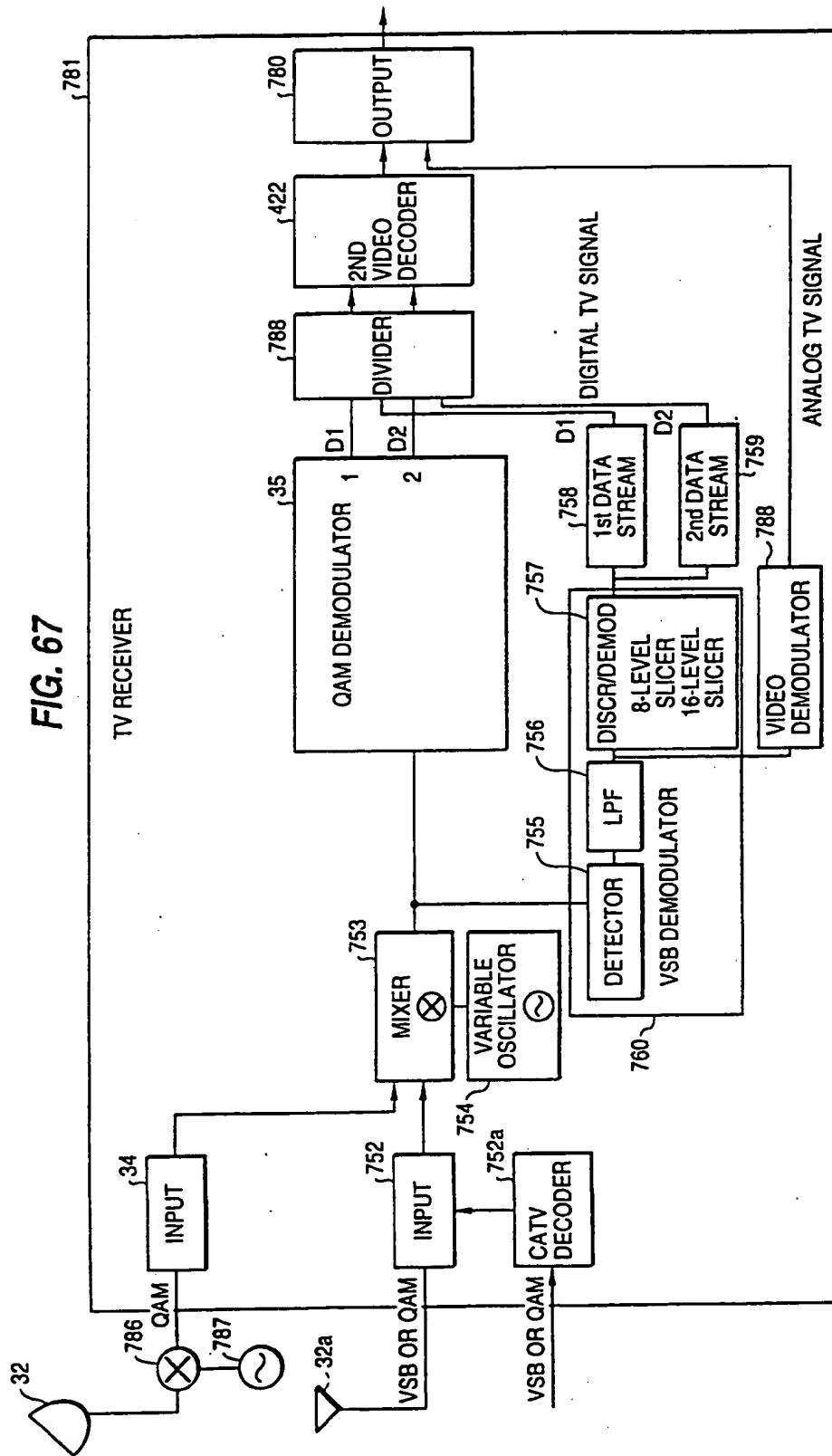


FIG. 67



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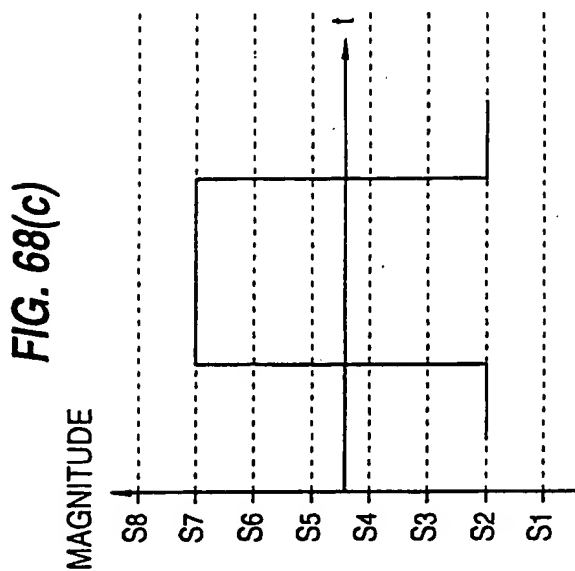
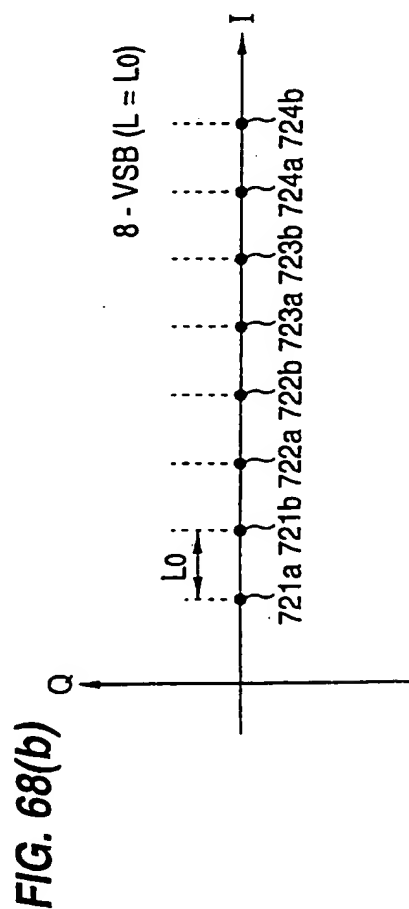
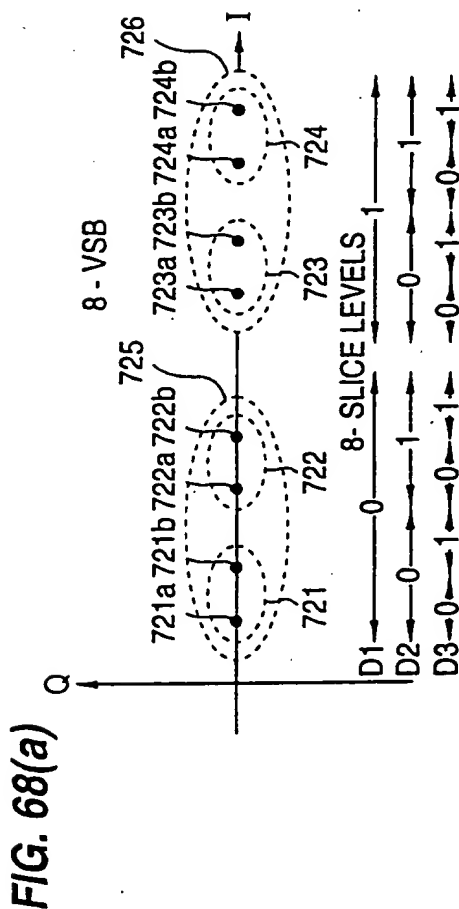


FIG. 69

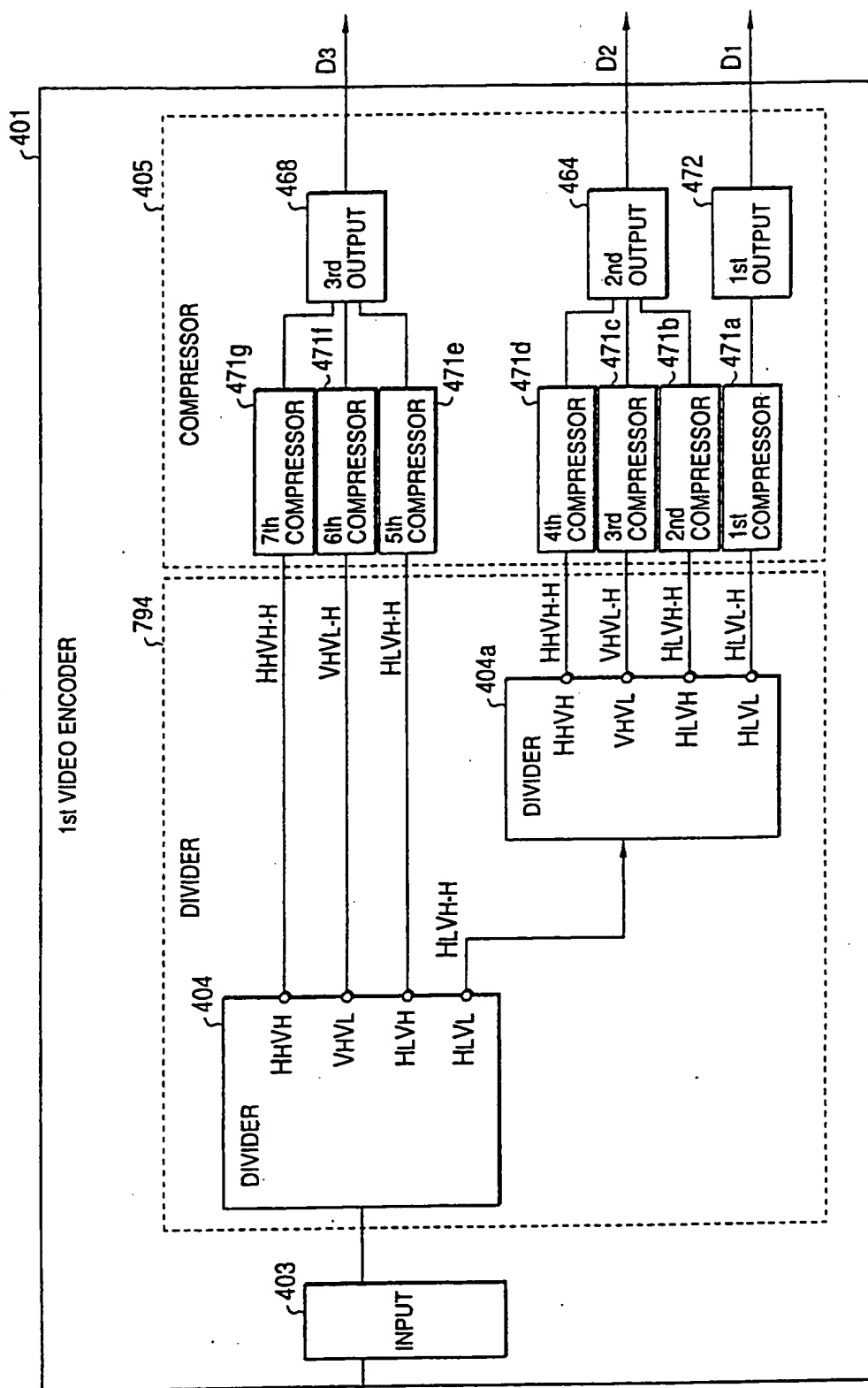


FIG. 70

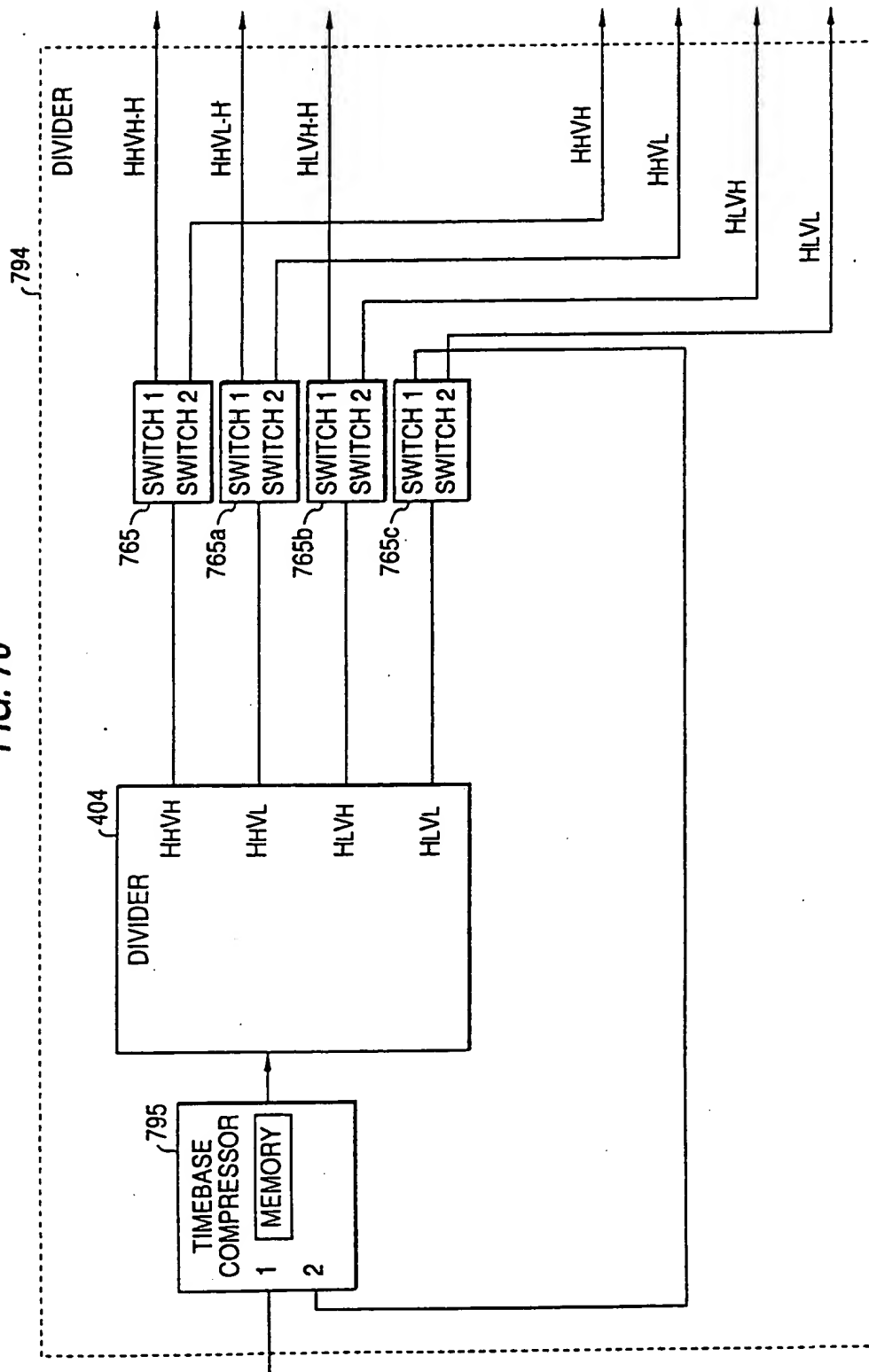


FIG. 71

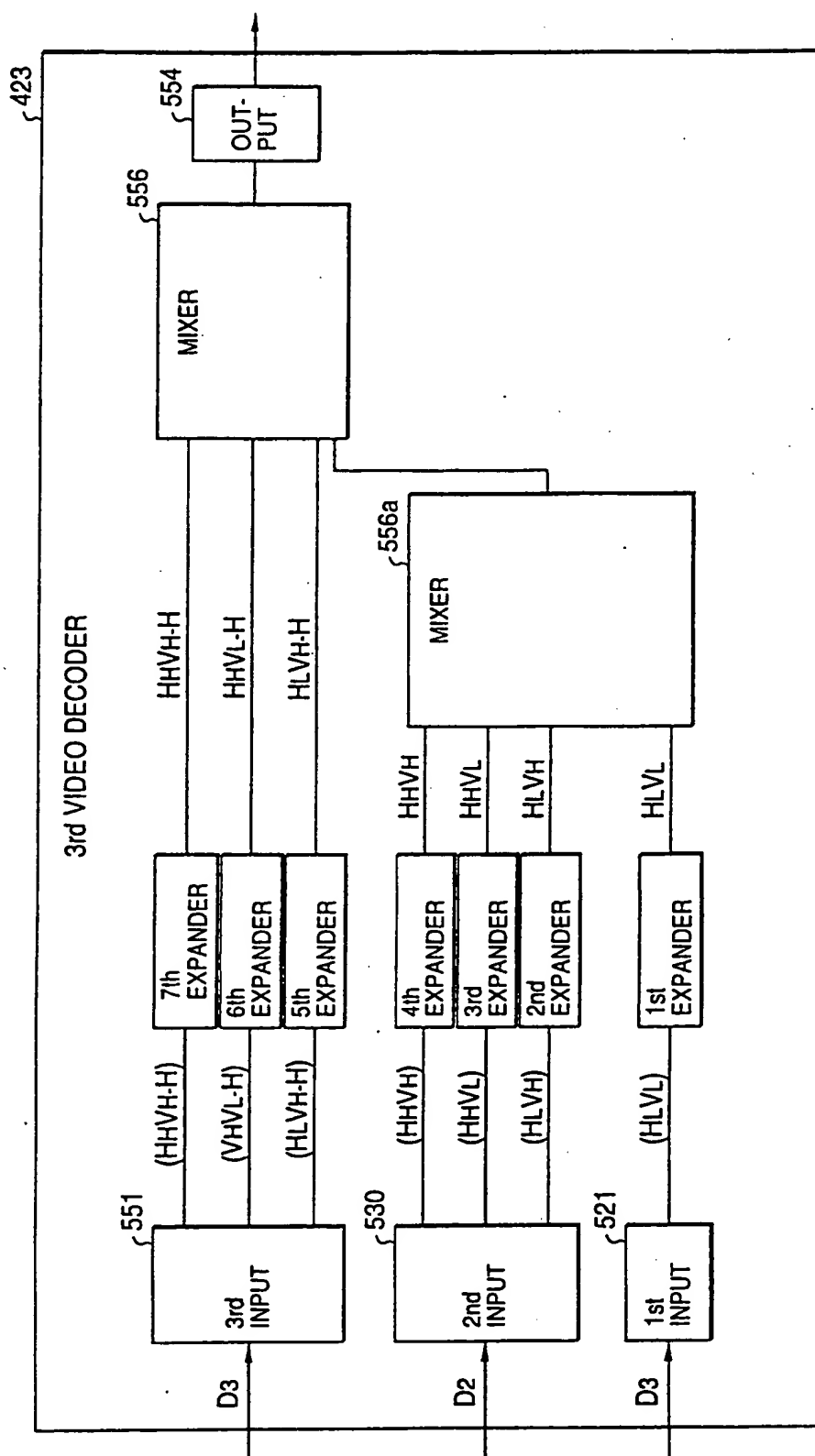


FIG. 72

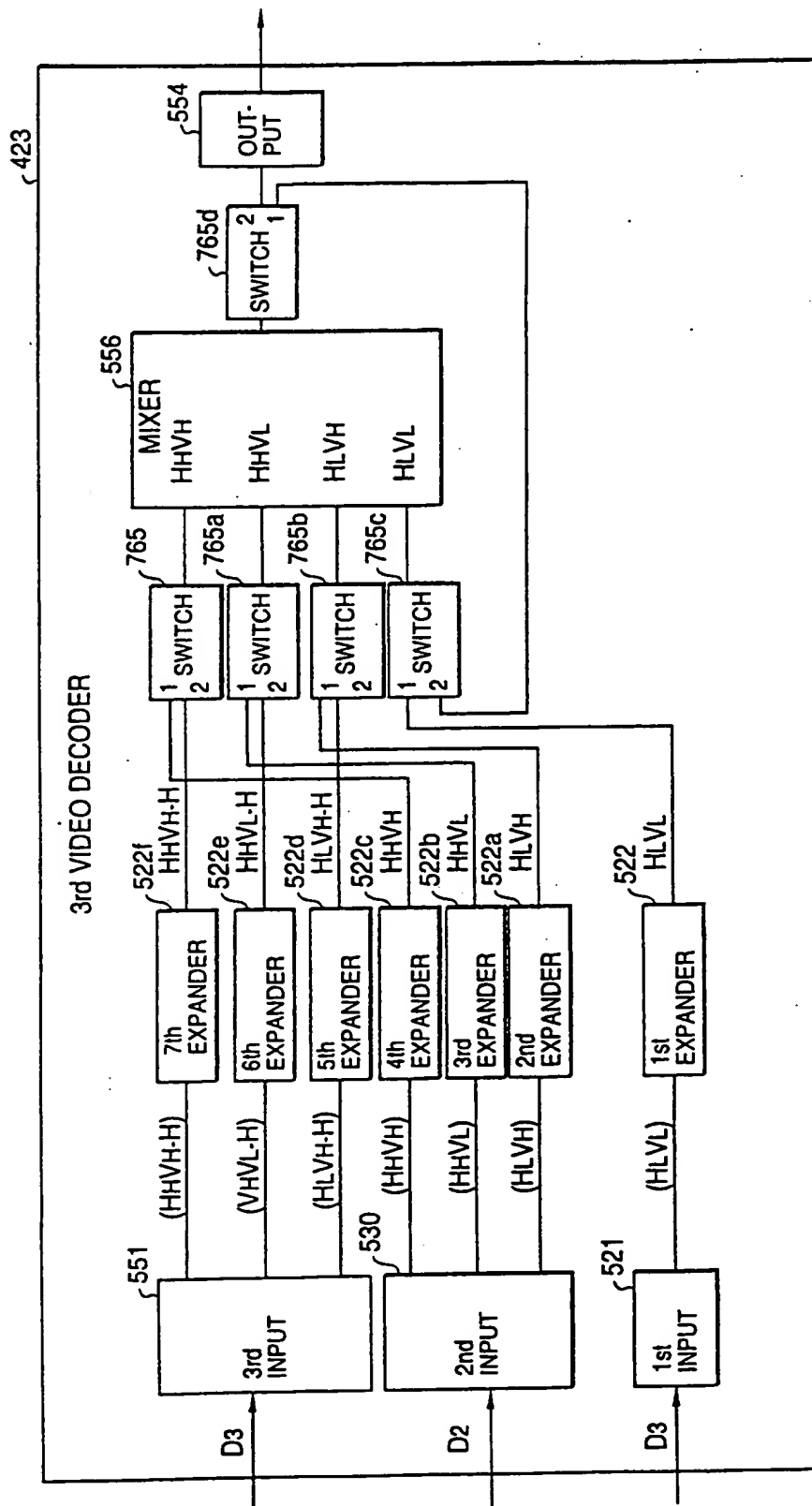


FIG. 73

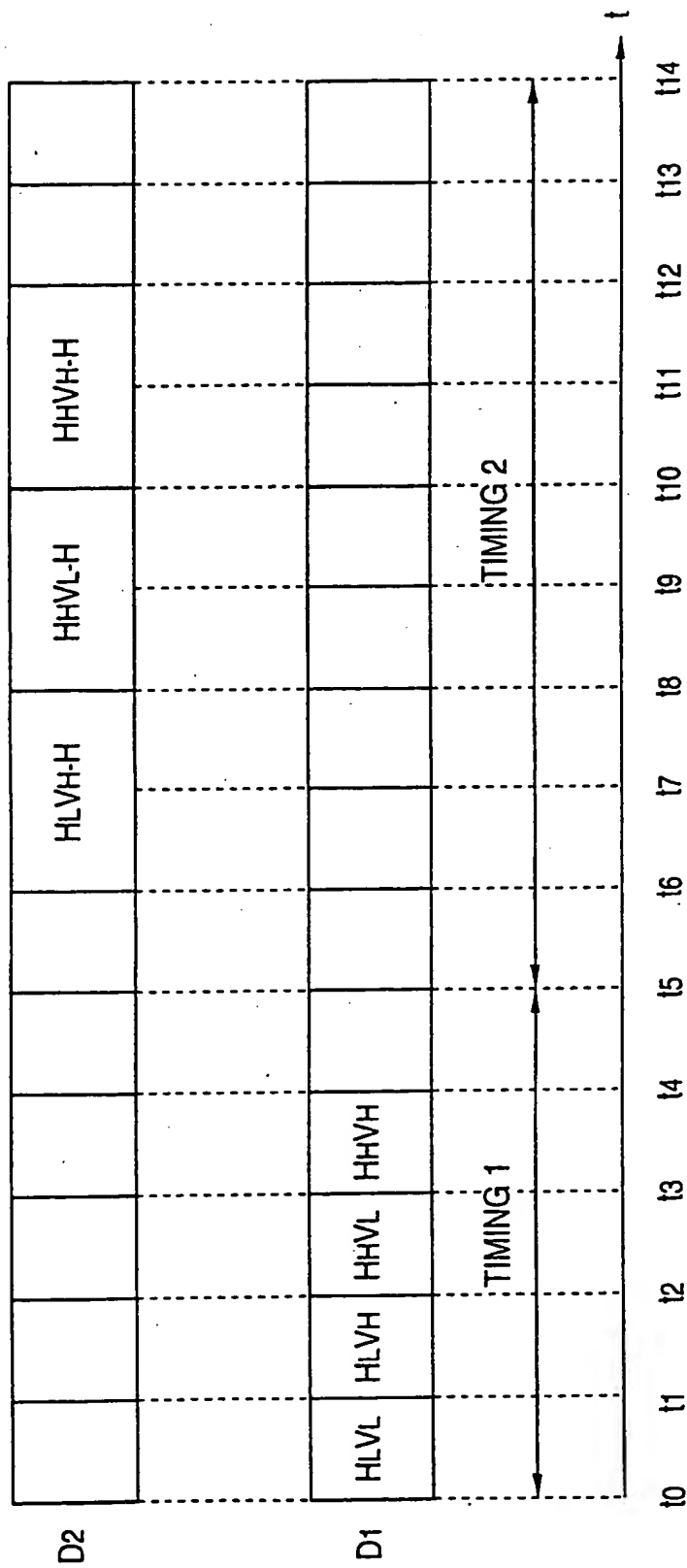


FIG. 74(a)

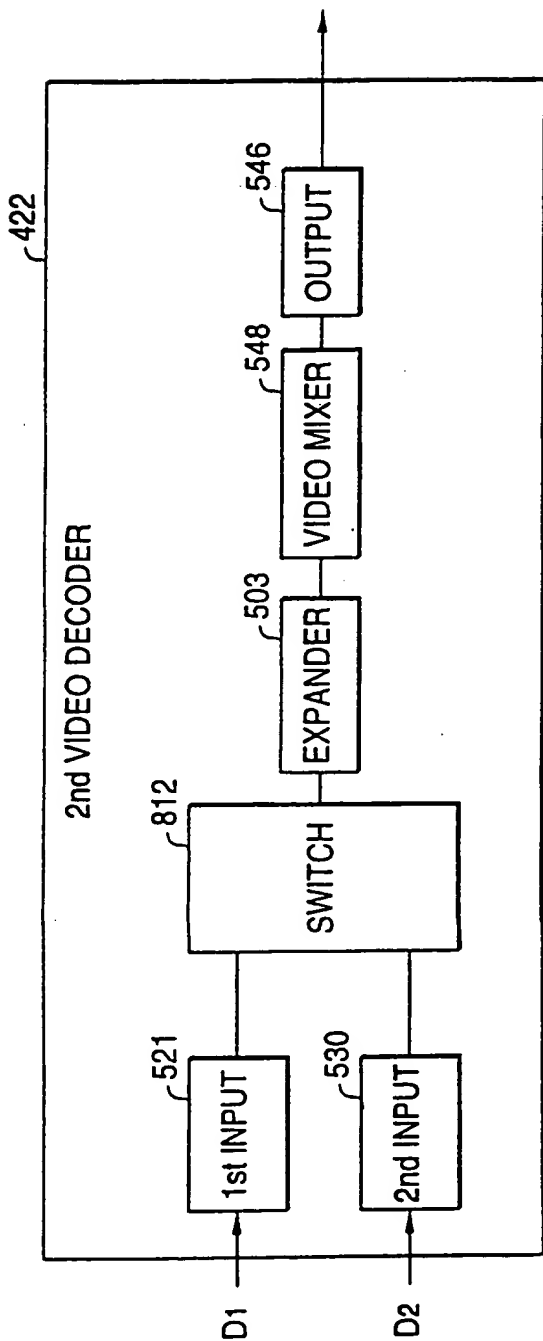


FIG. 74(b)

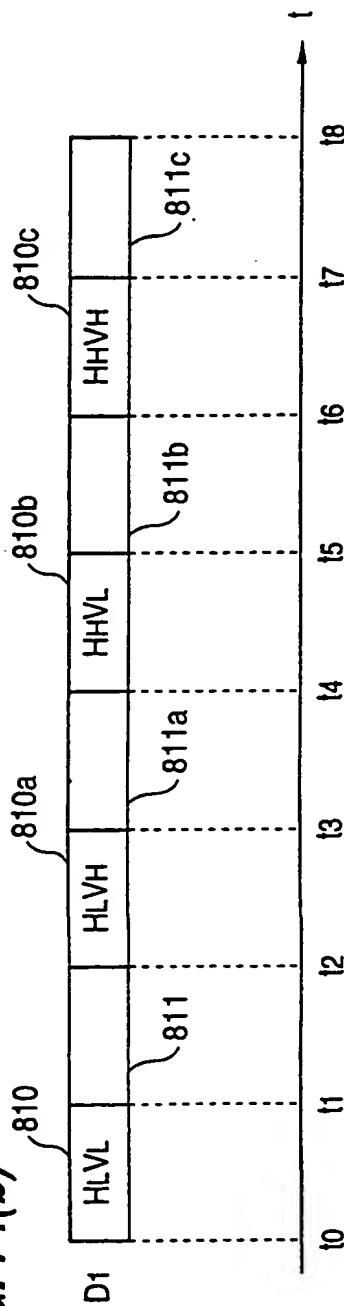


FIG. 75

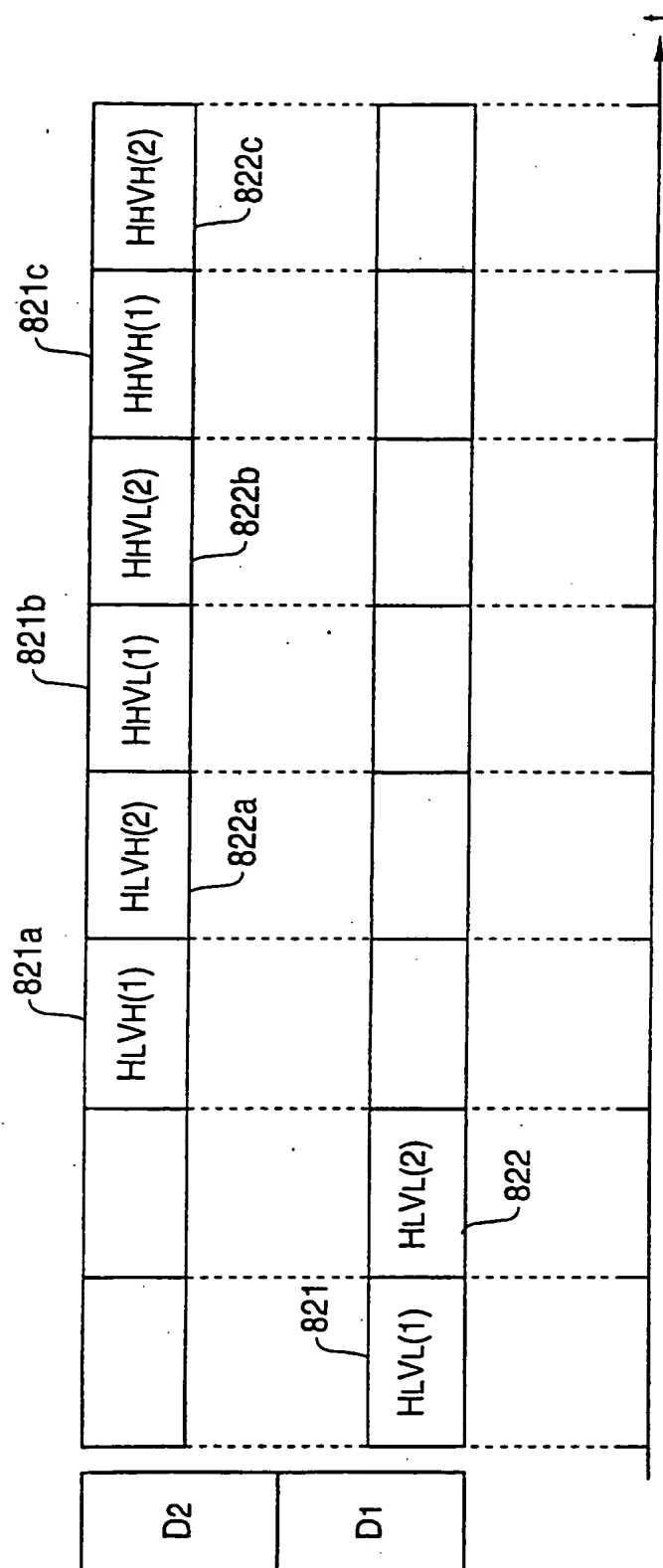
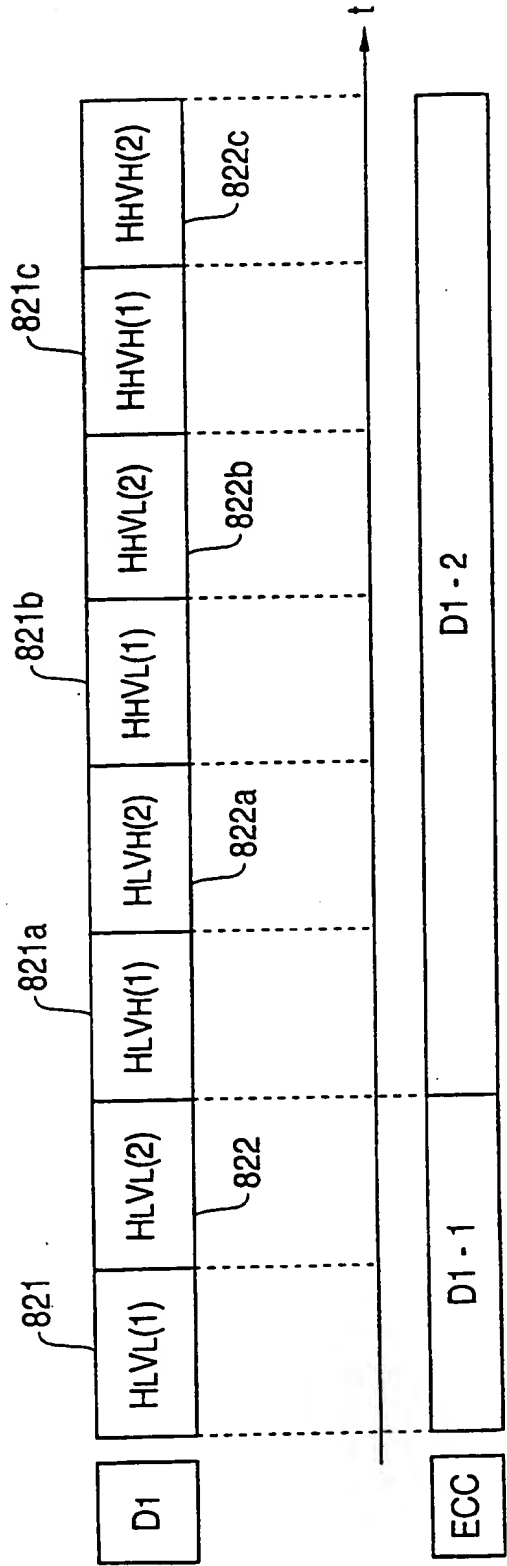


FIG. 76



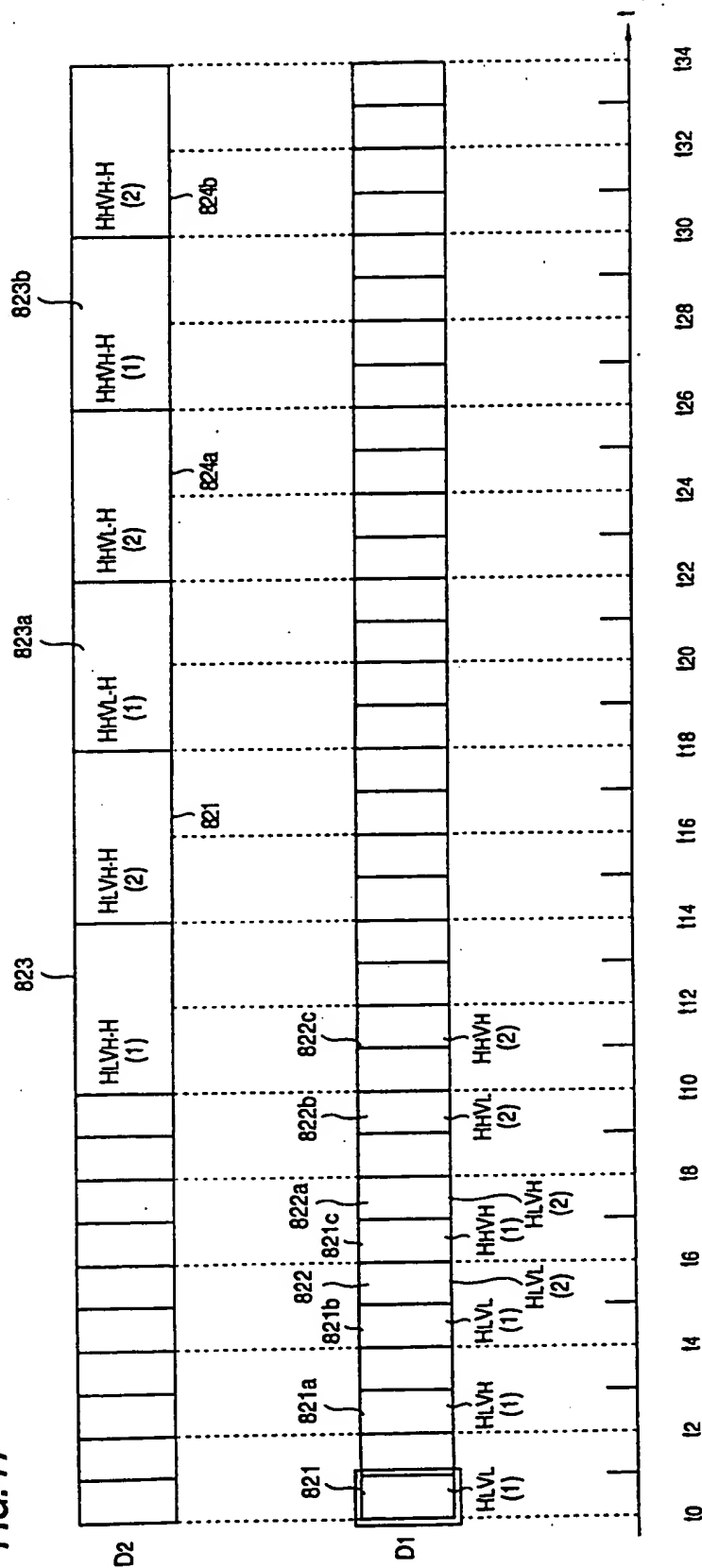
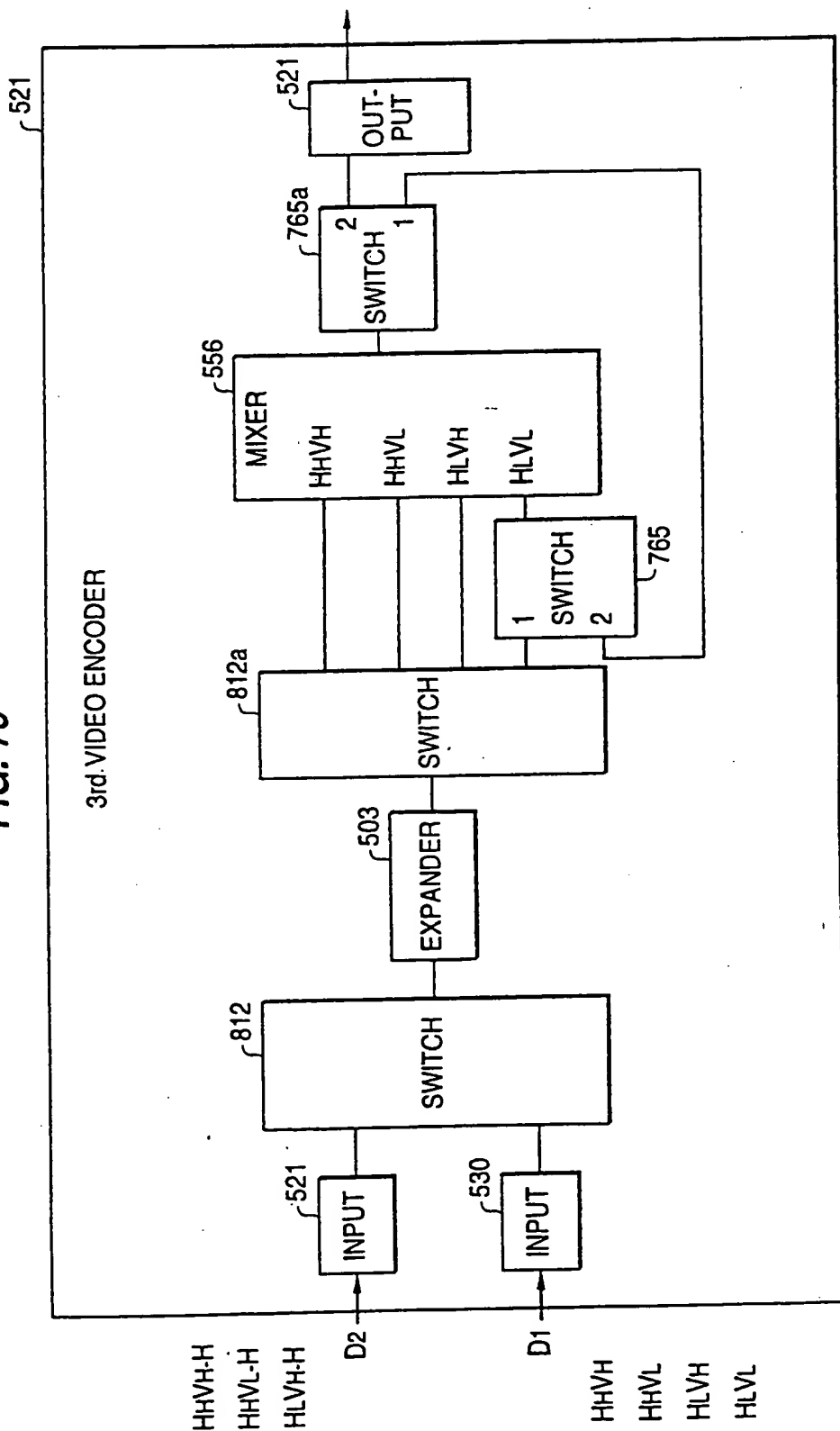


FIG. 78



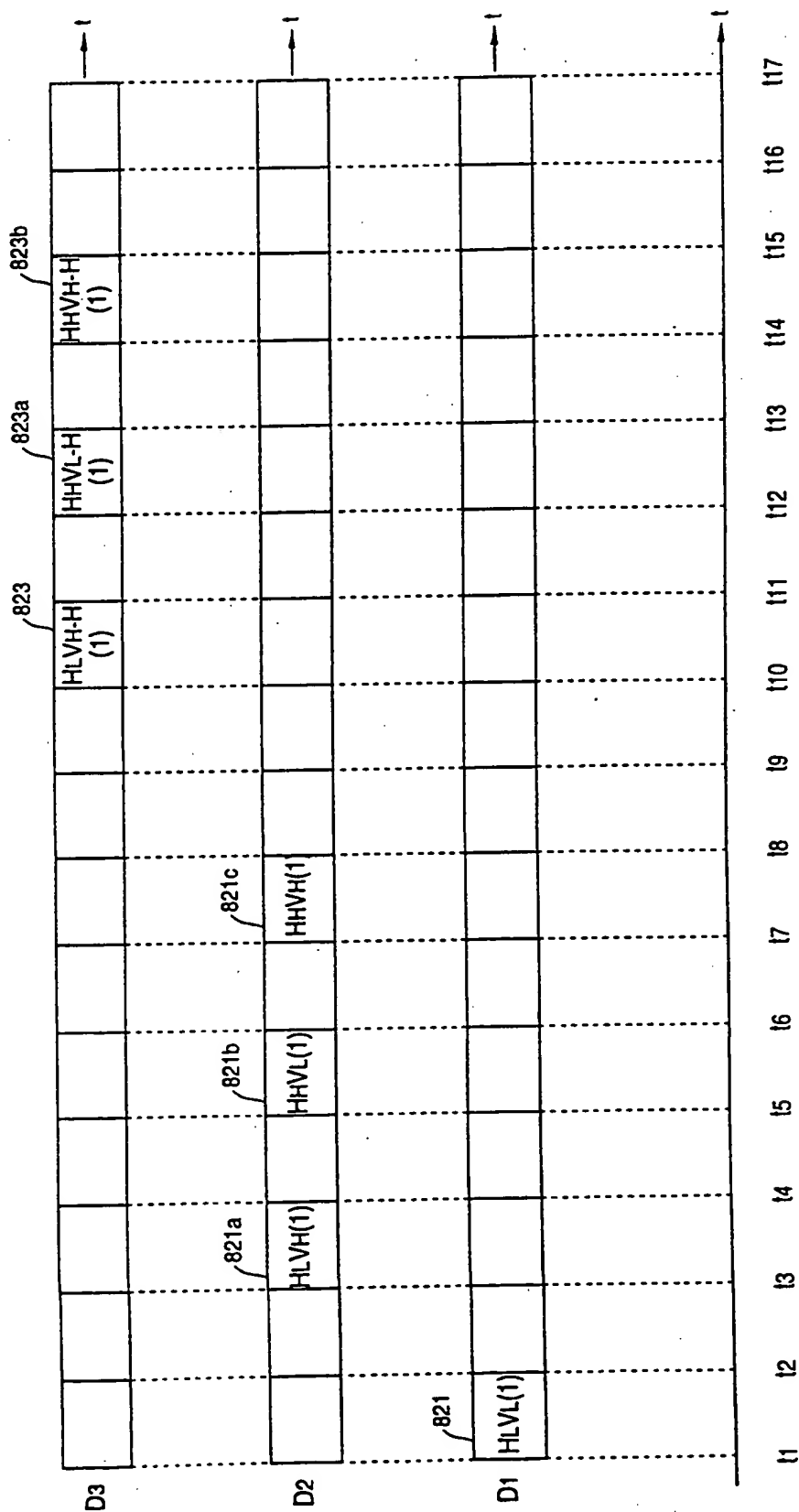


FIG. 80

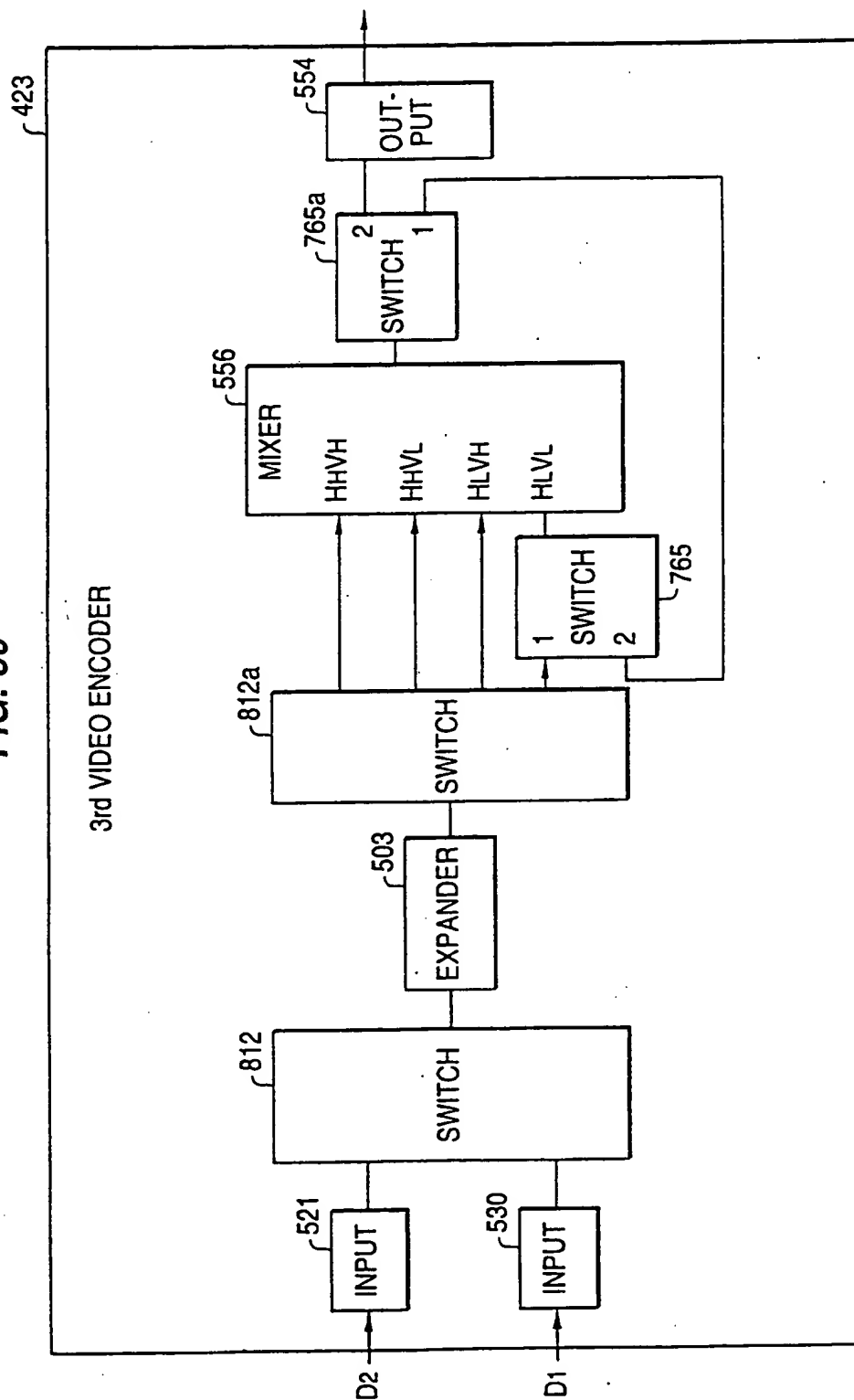


FIG. 81

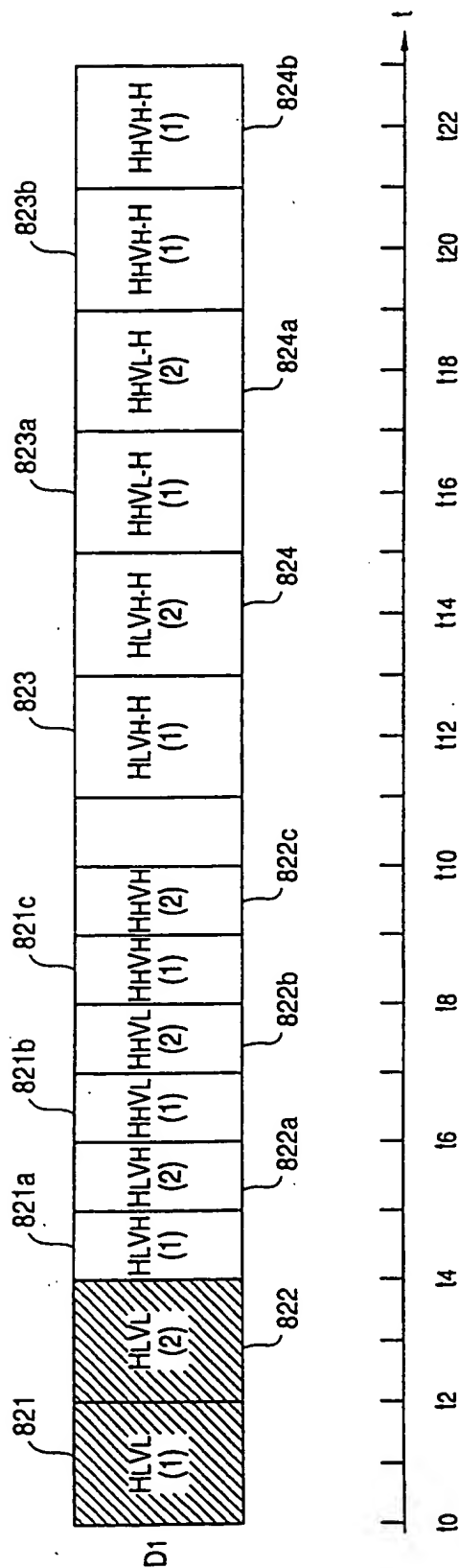


FIG. 82

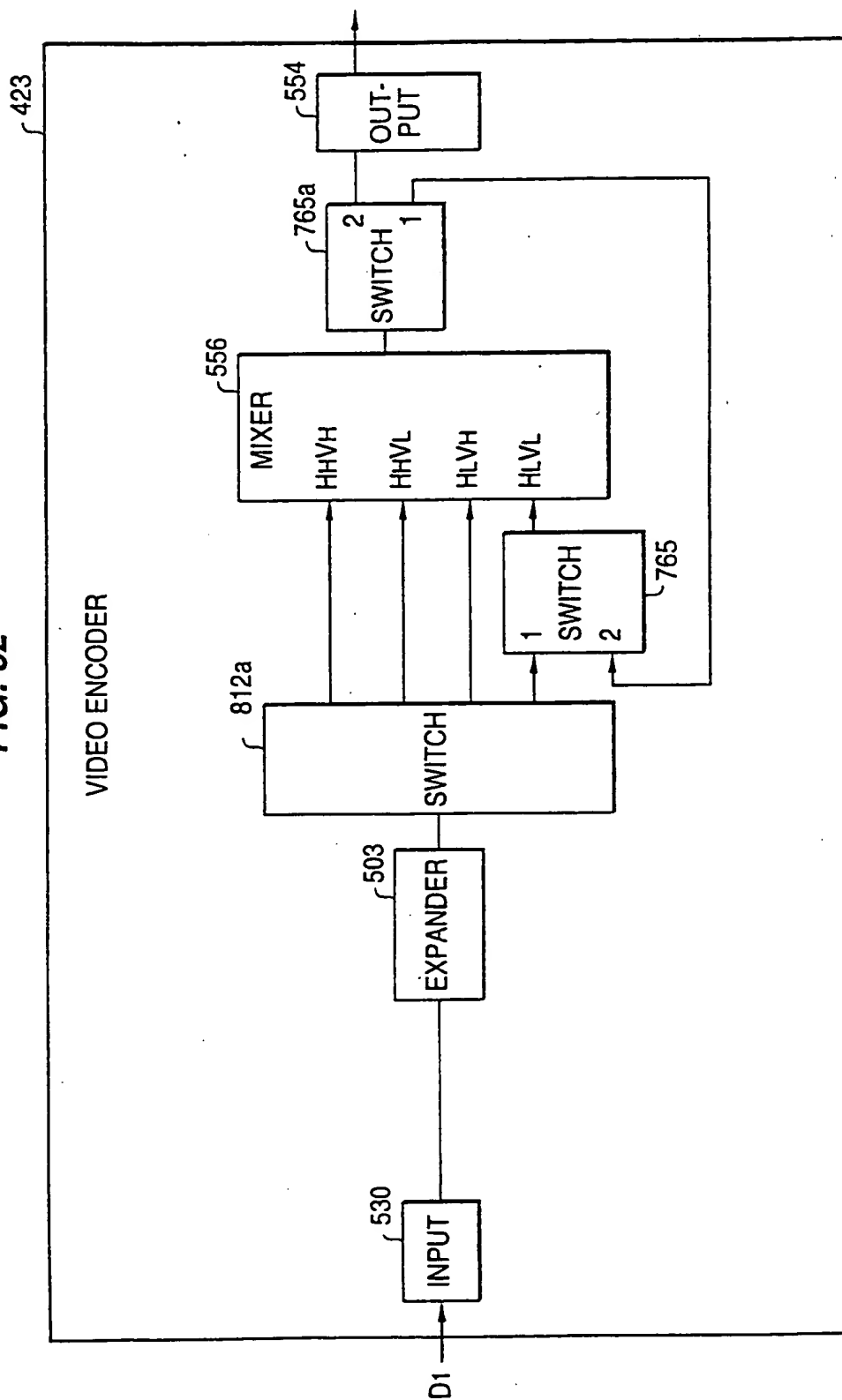


FIG. 83

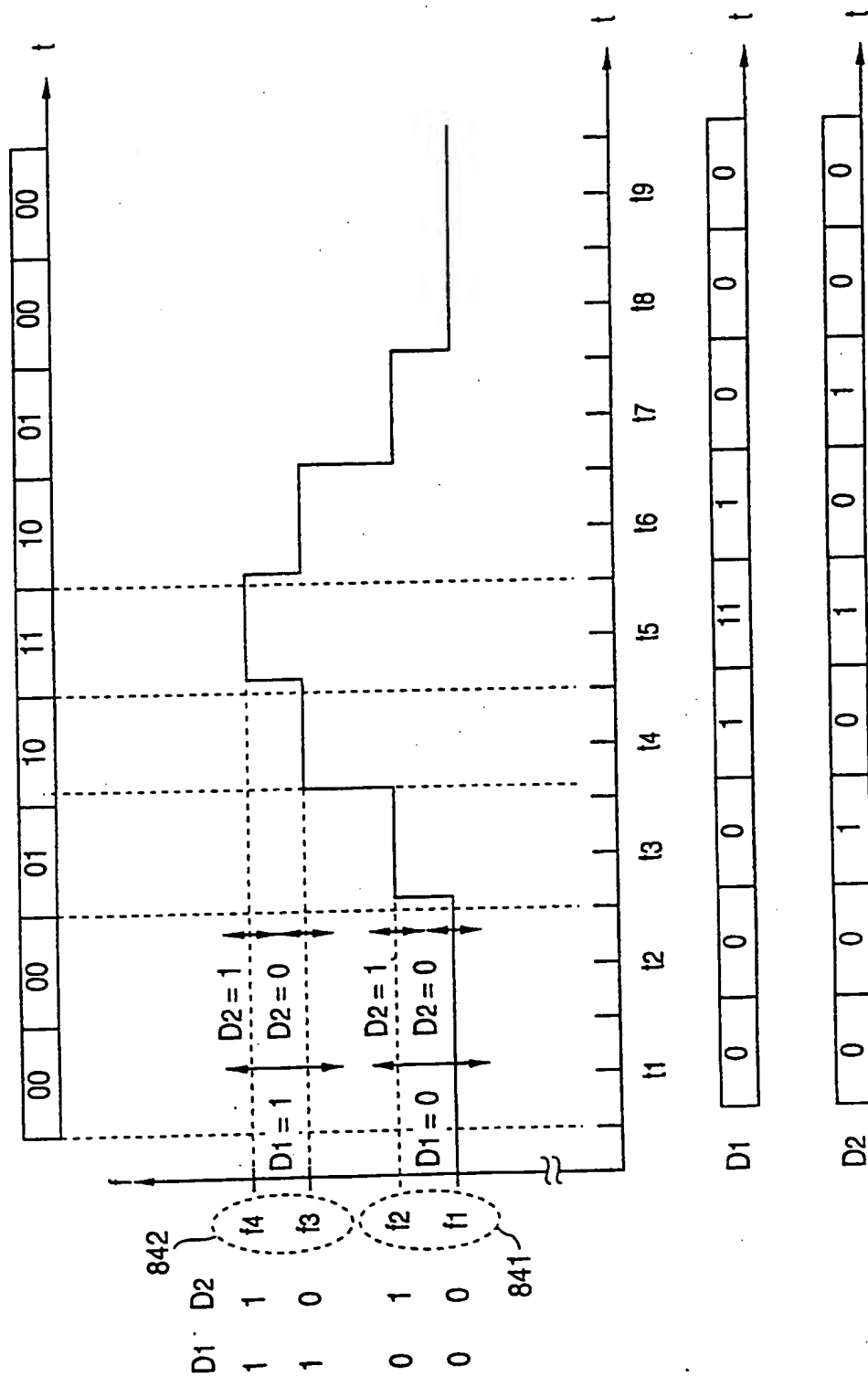


FIG. 84

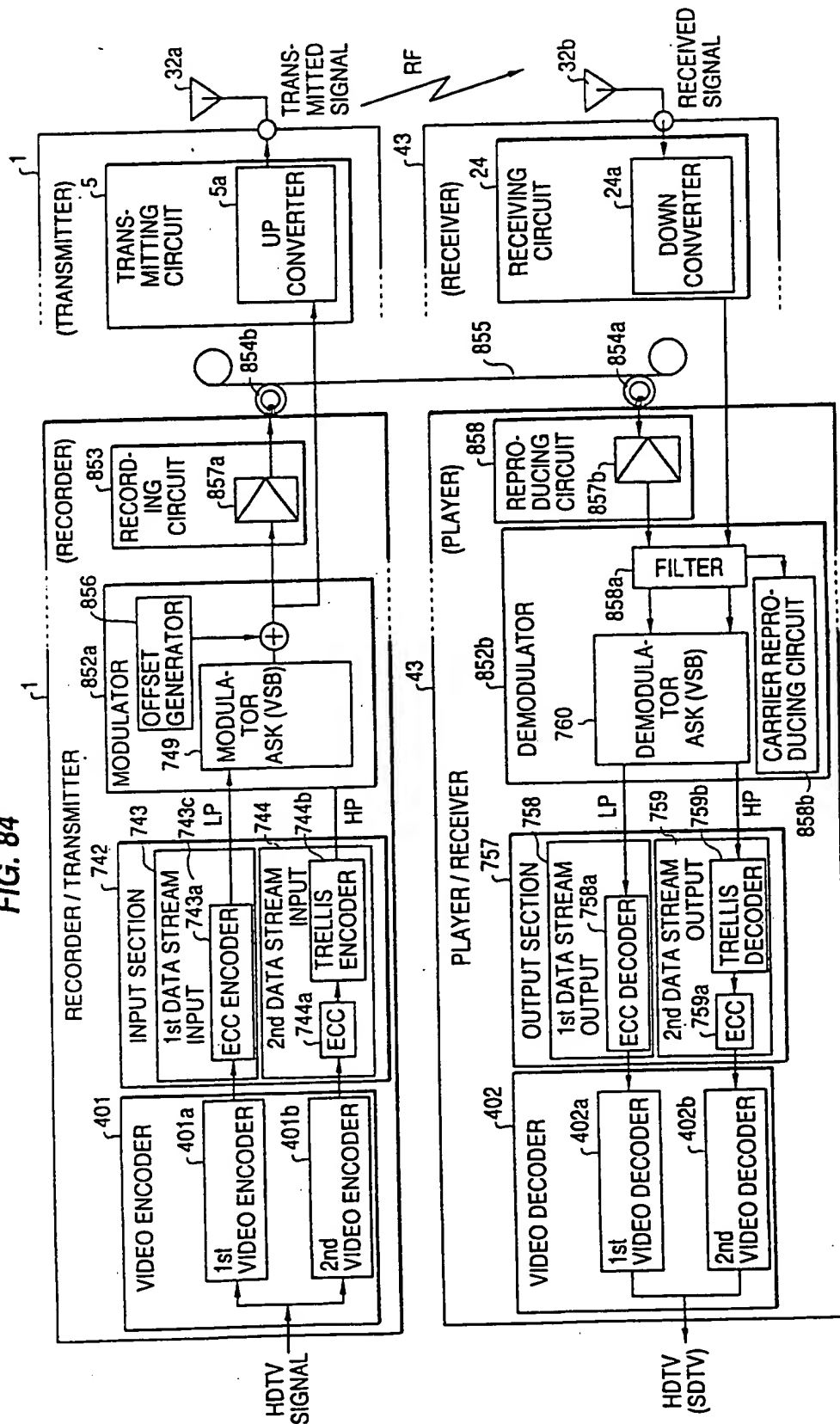


FIG. 85

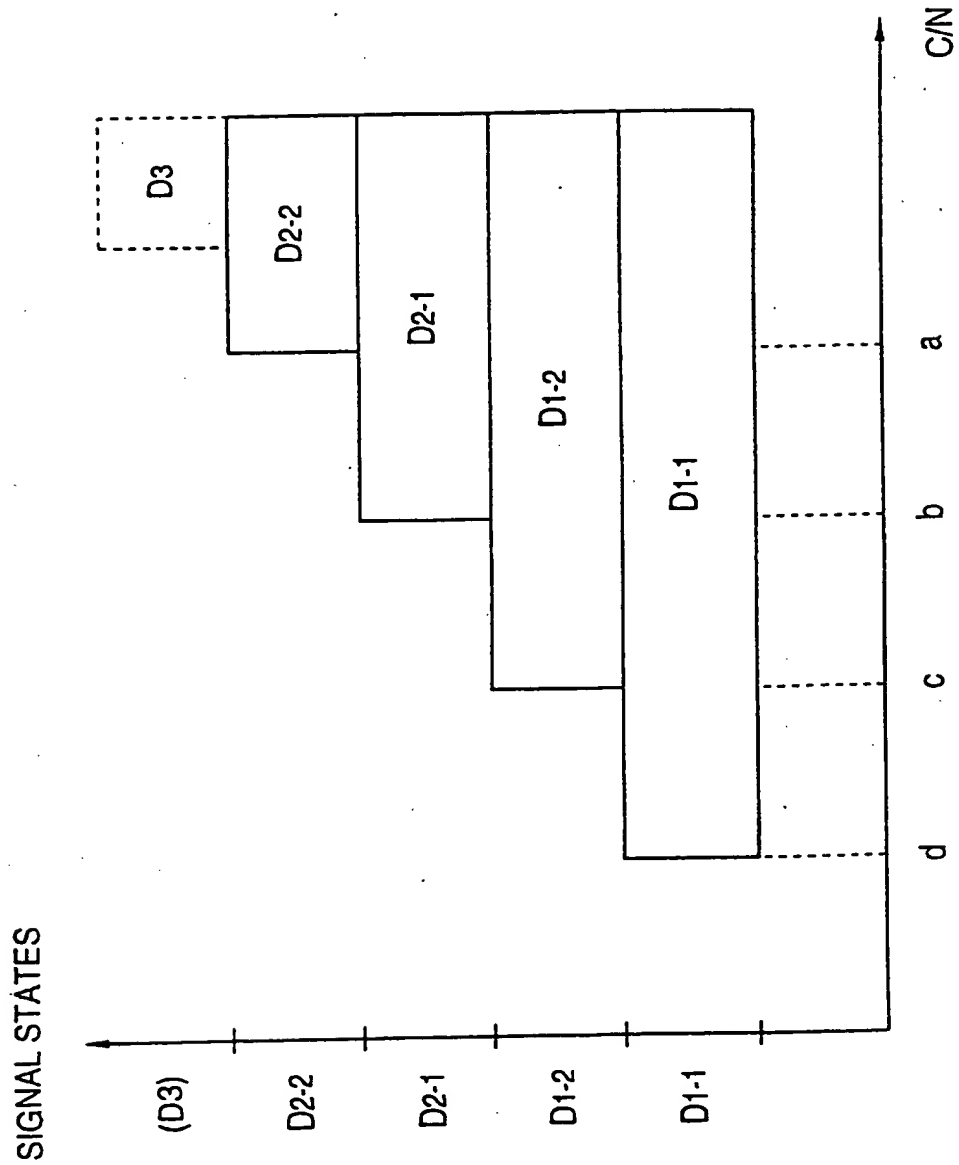


FIG. 86

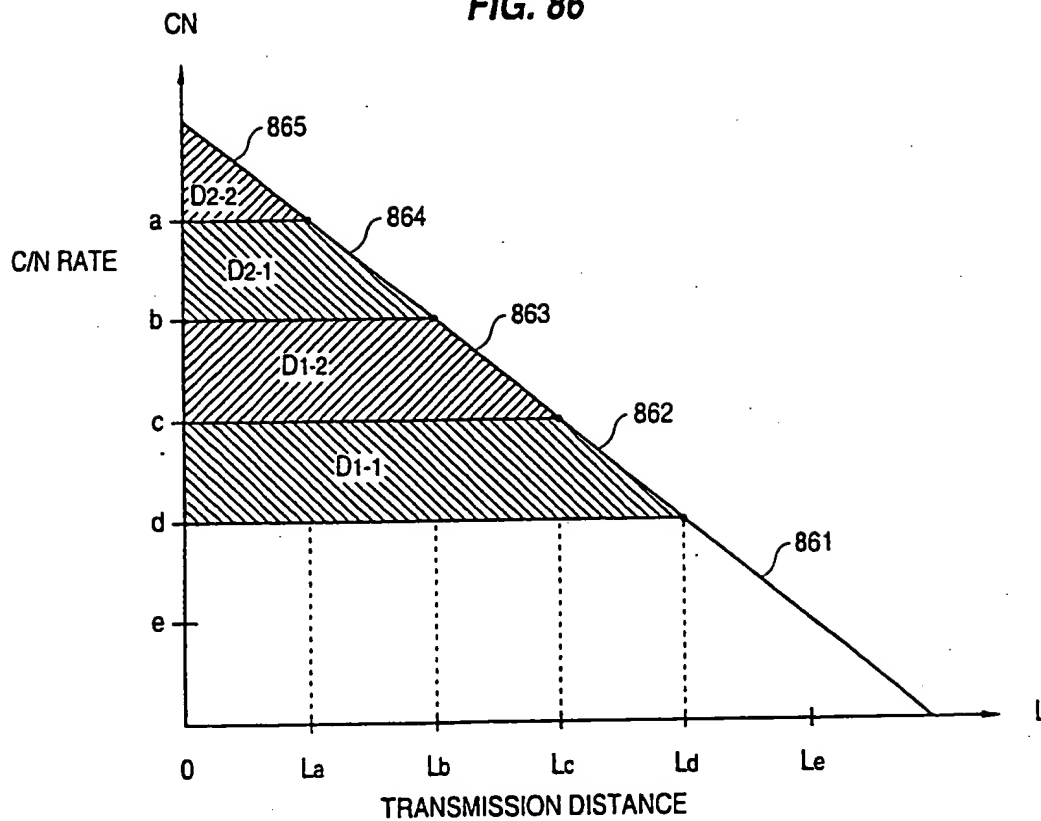


FIG. 87

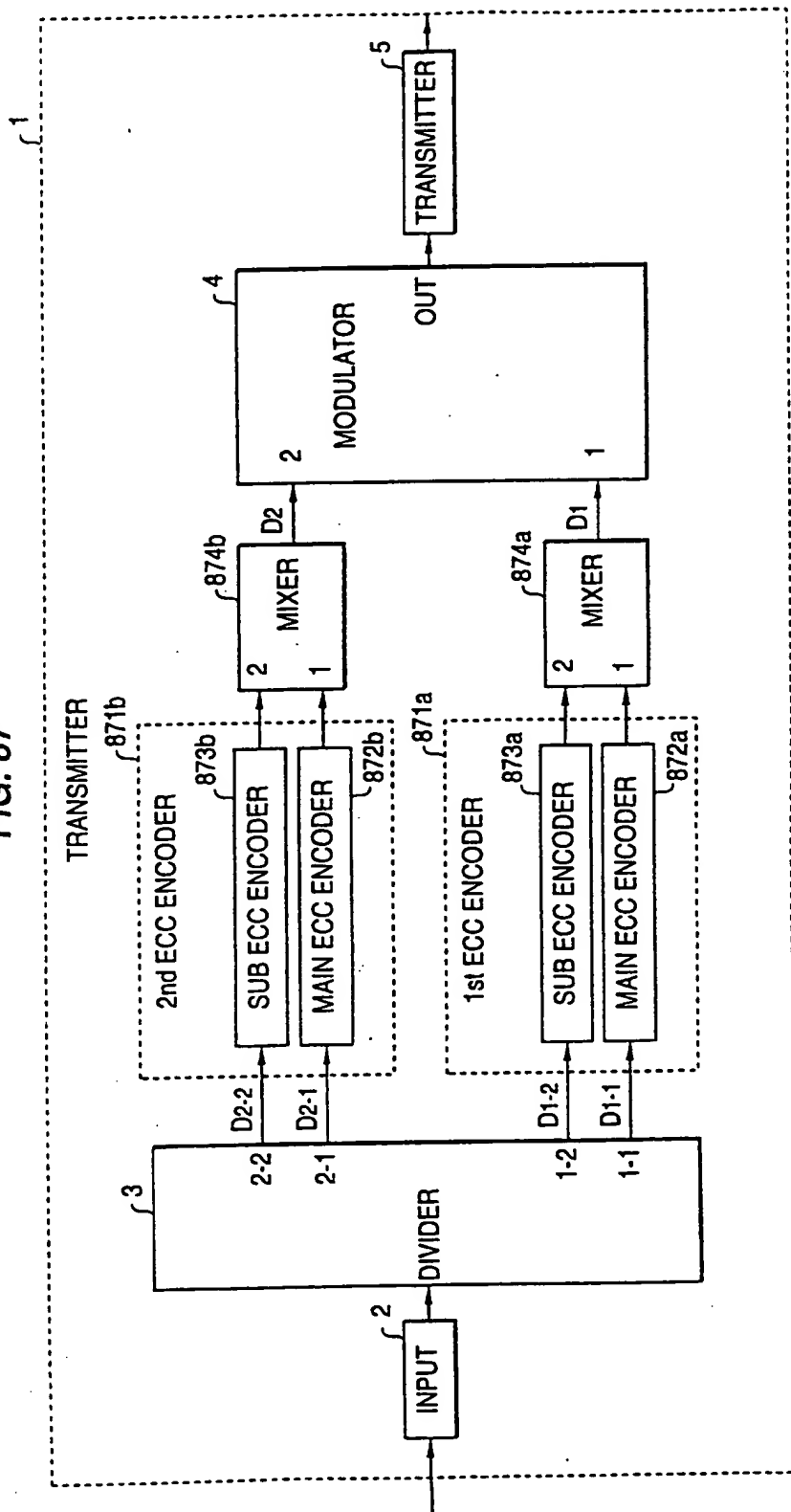


FIG. 88

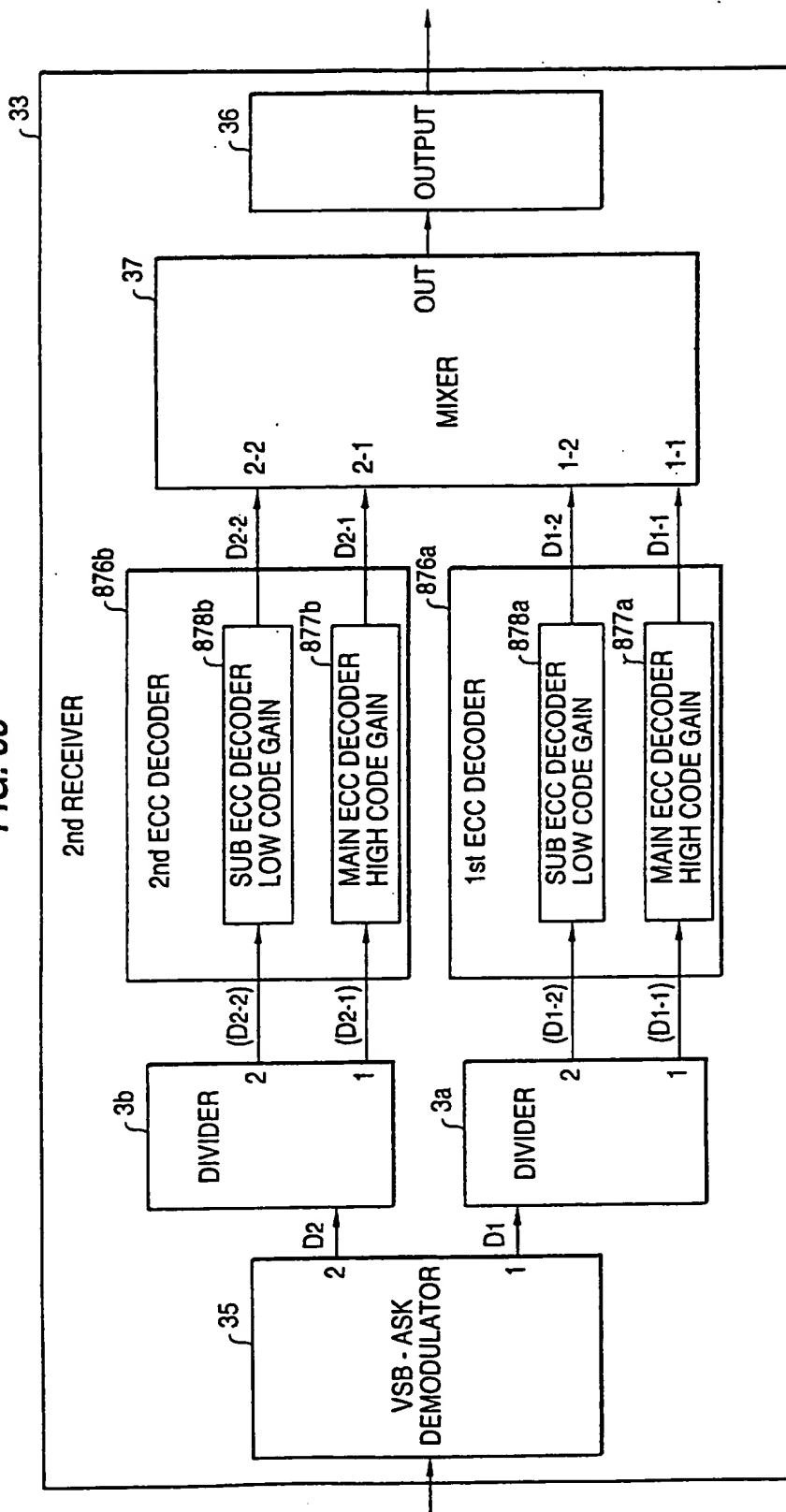


FIG. 89

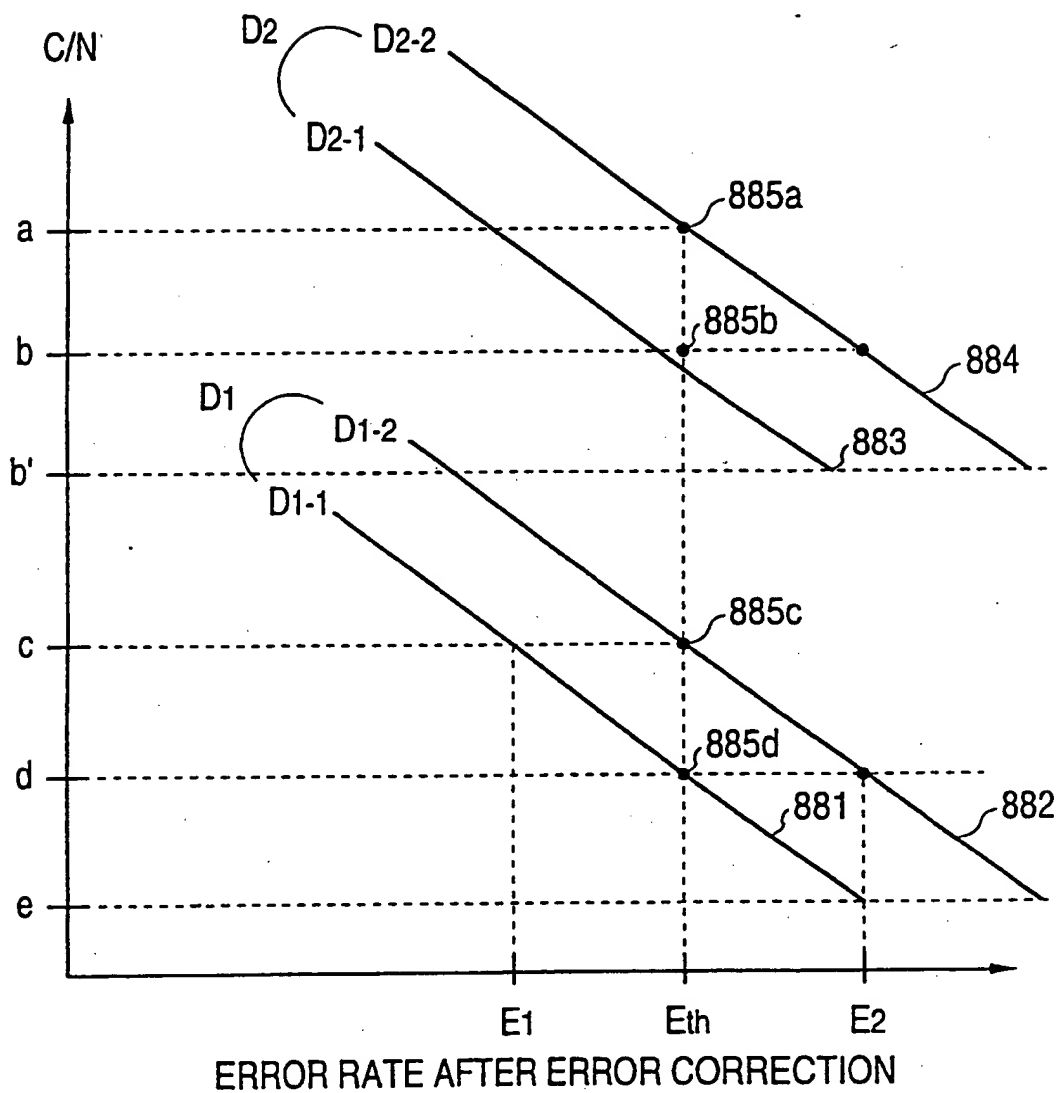
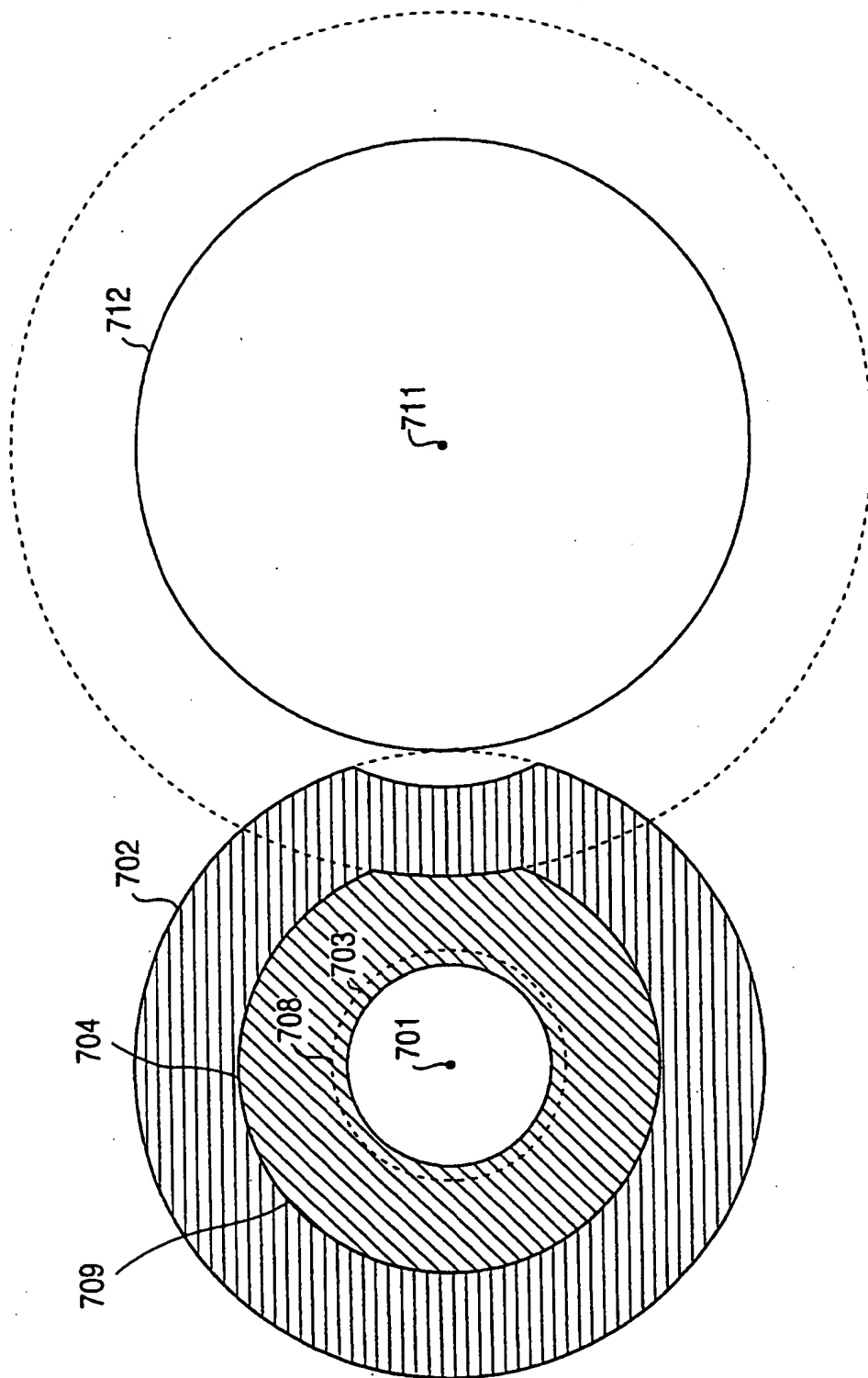
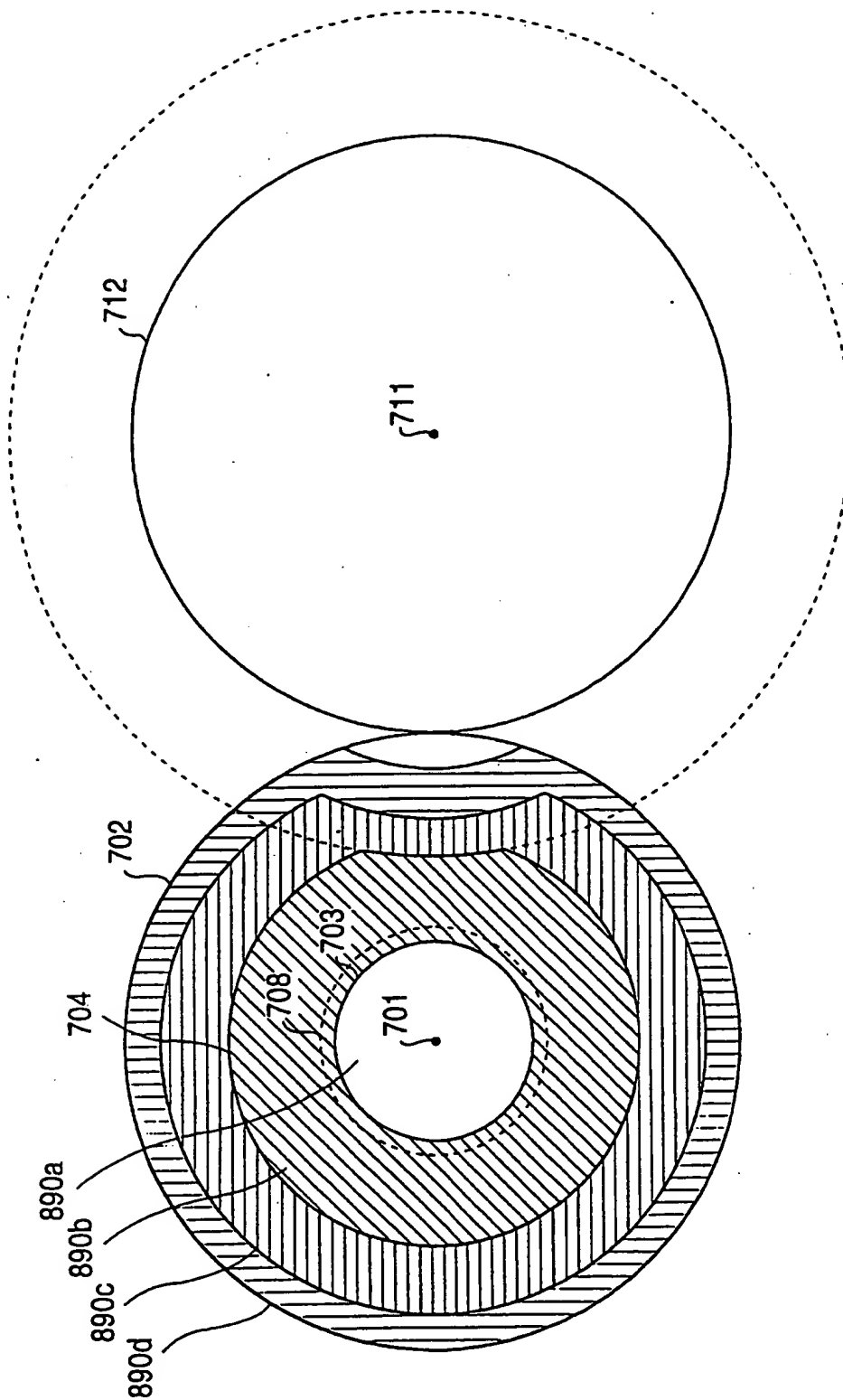


FIG. 90



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FIG. 91



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FIG. 92

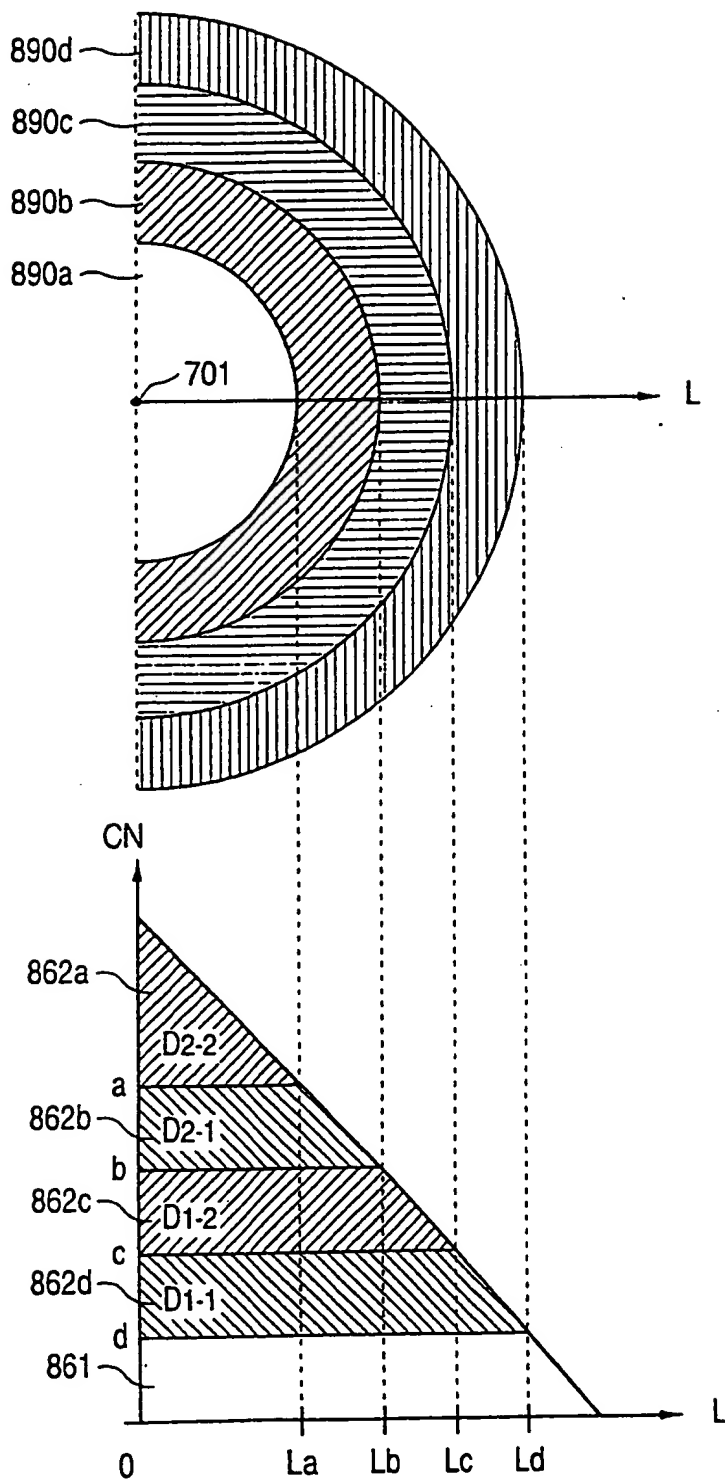


FIG. 93

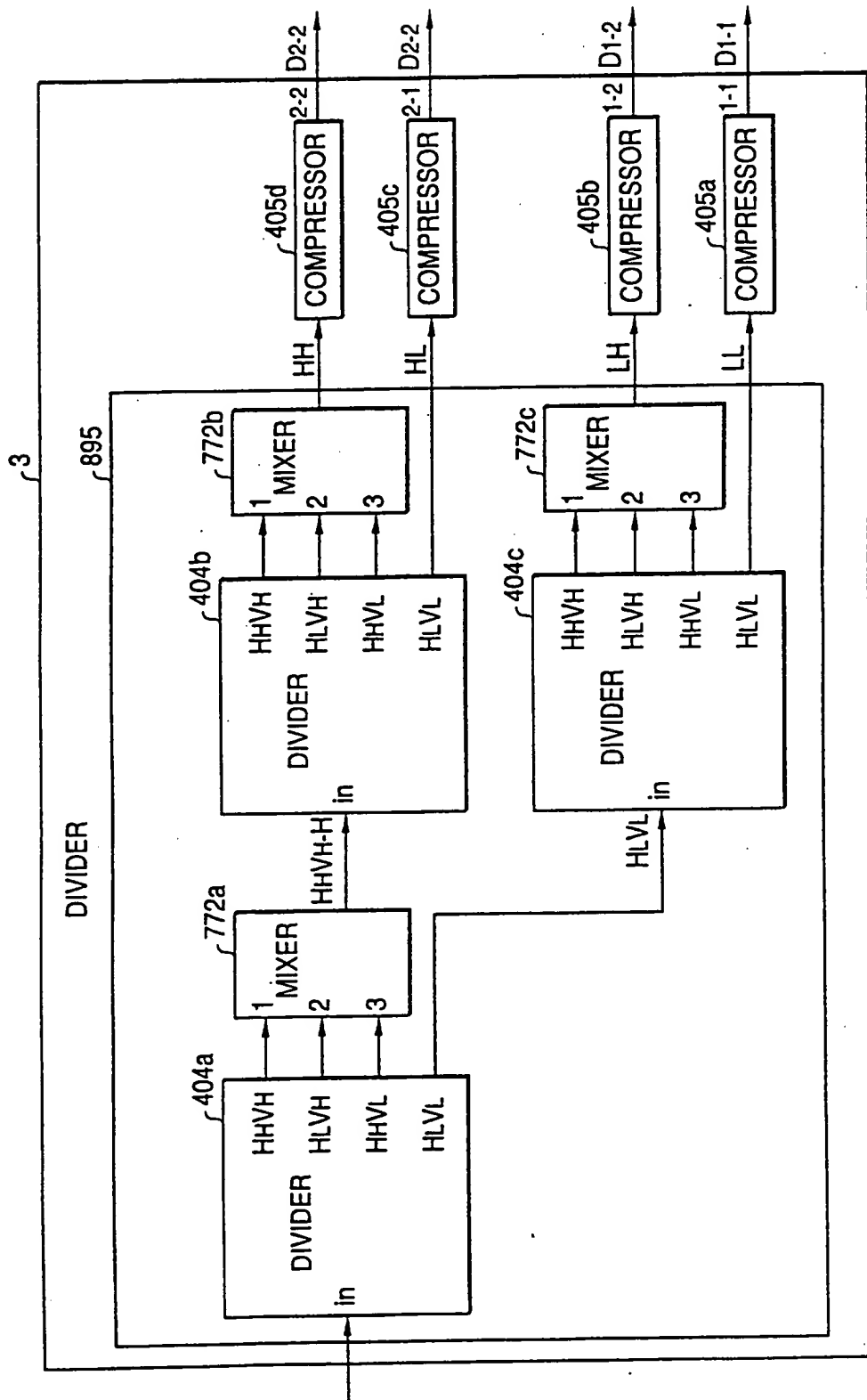


FIG. 94

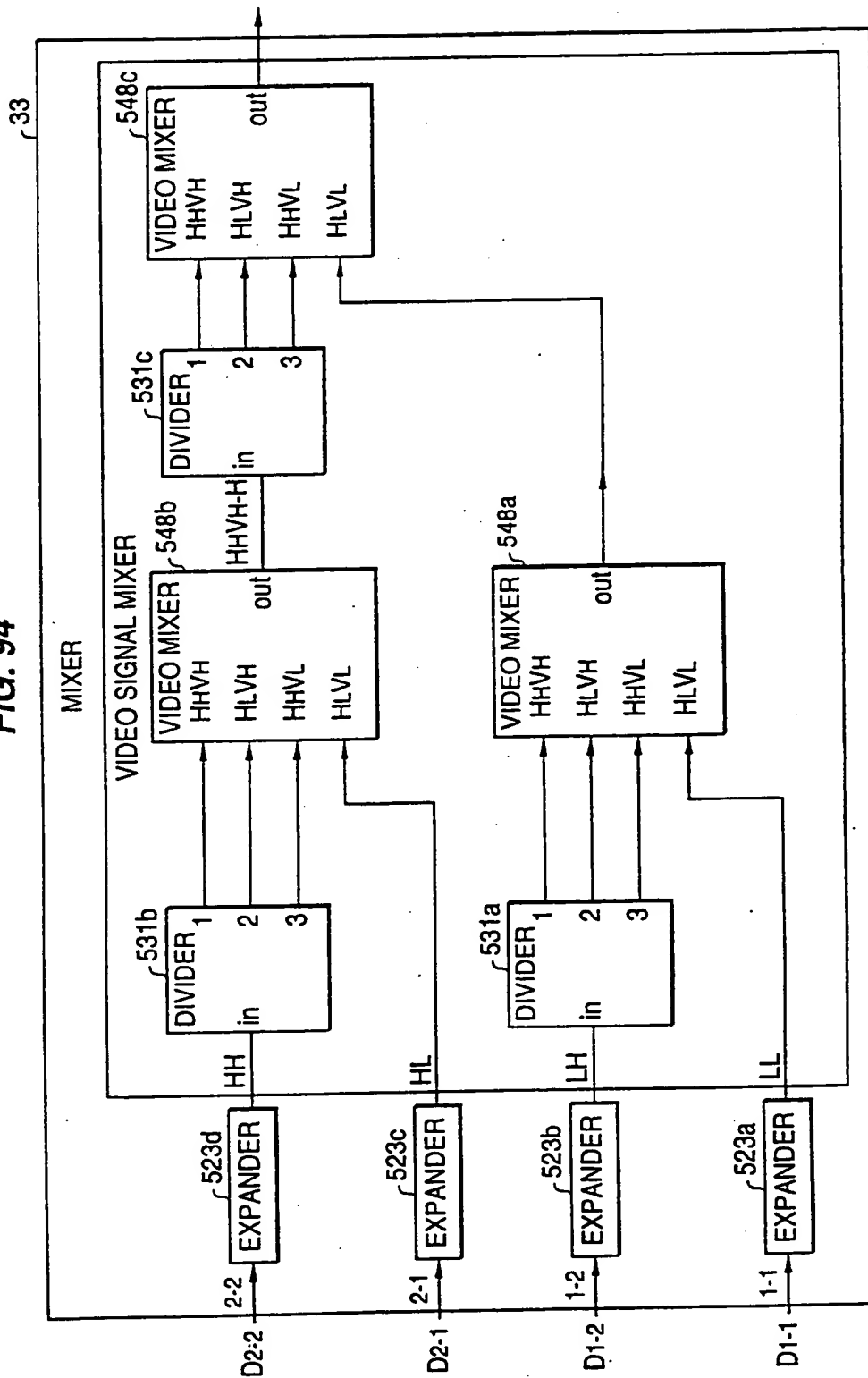


FIG. 95

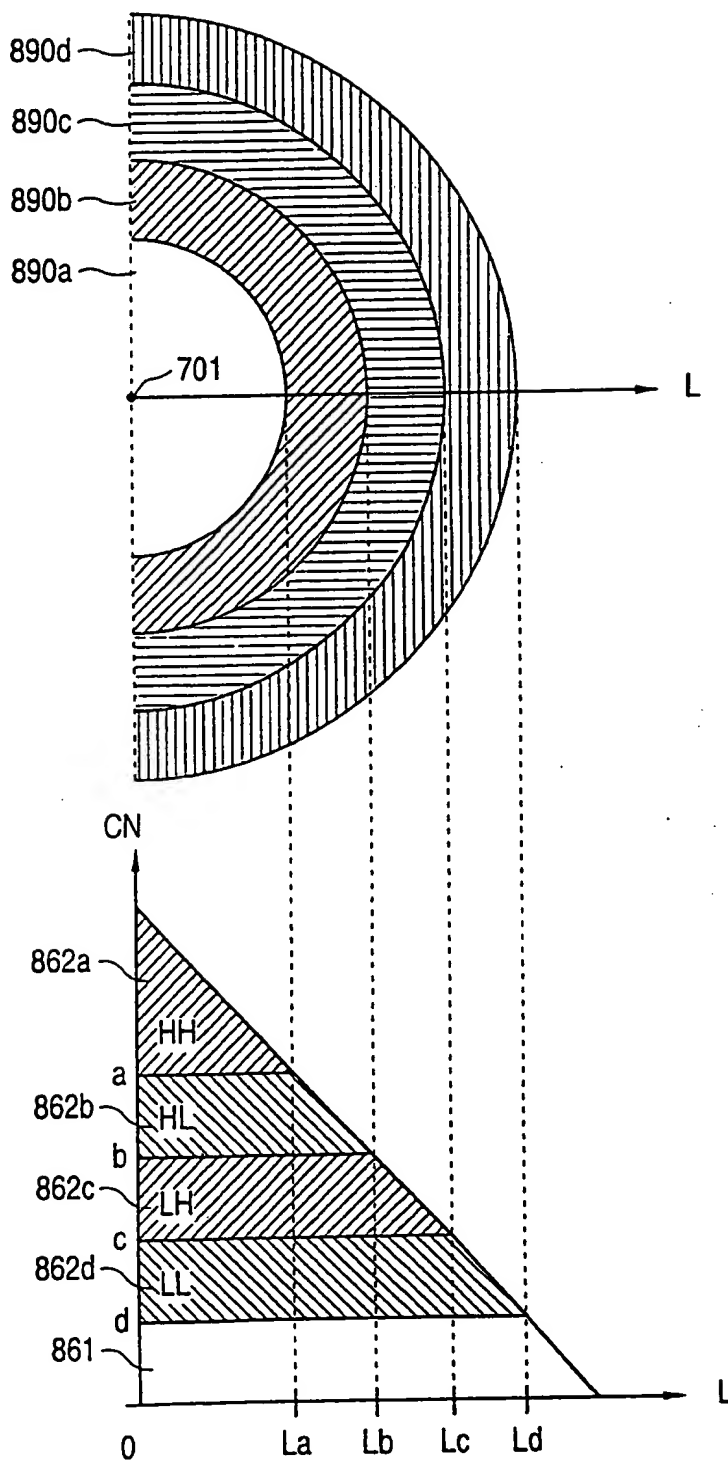


FIG. 96

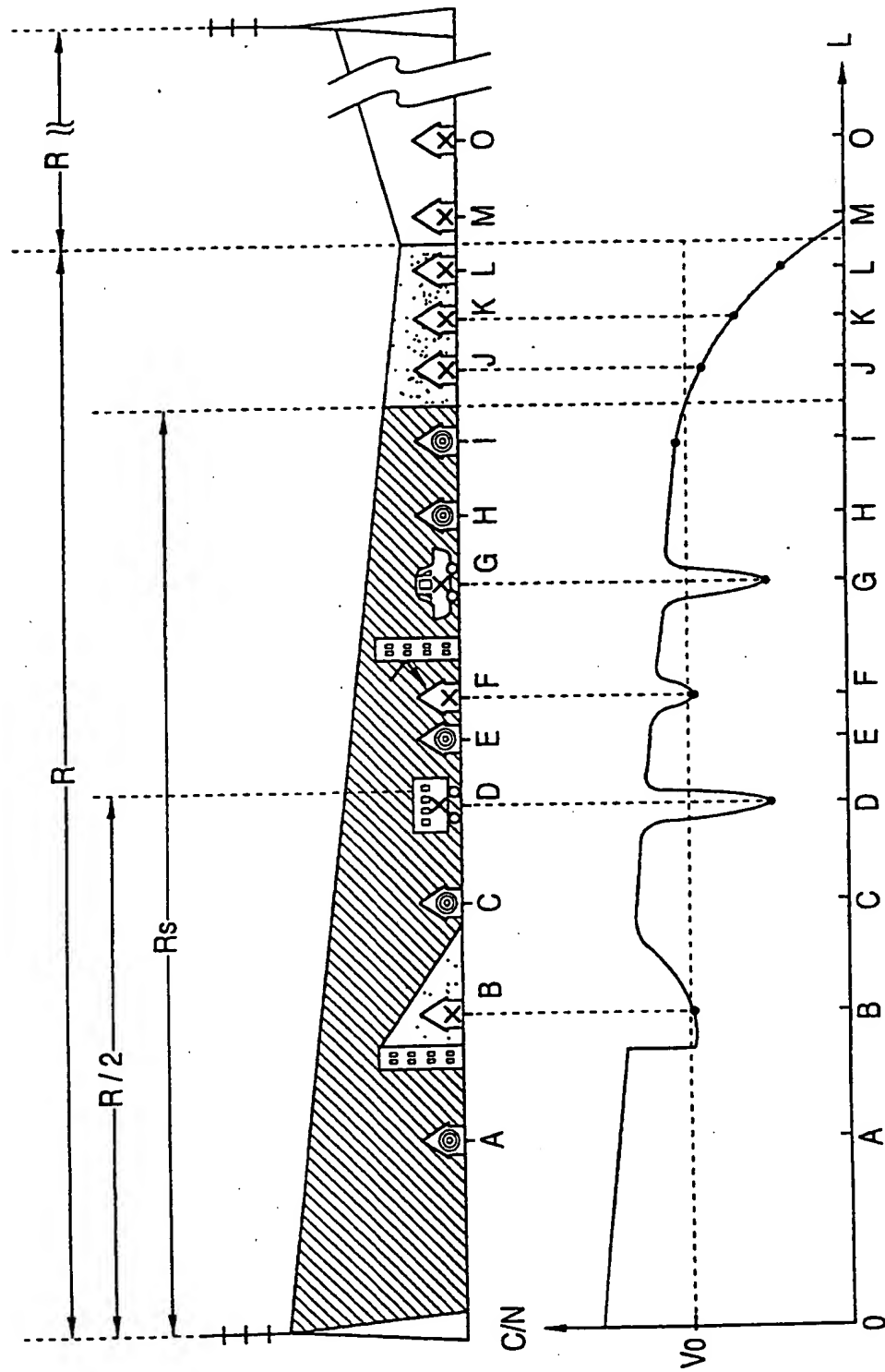


FIG. 97

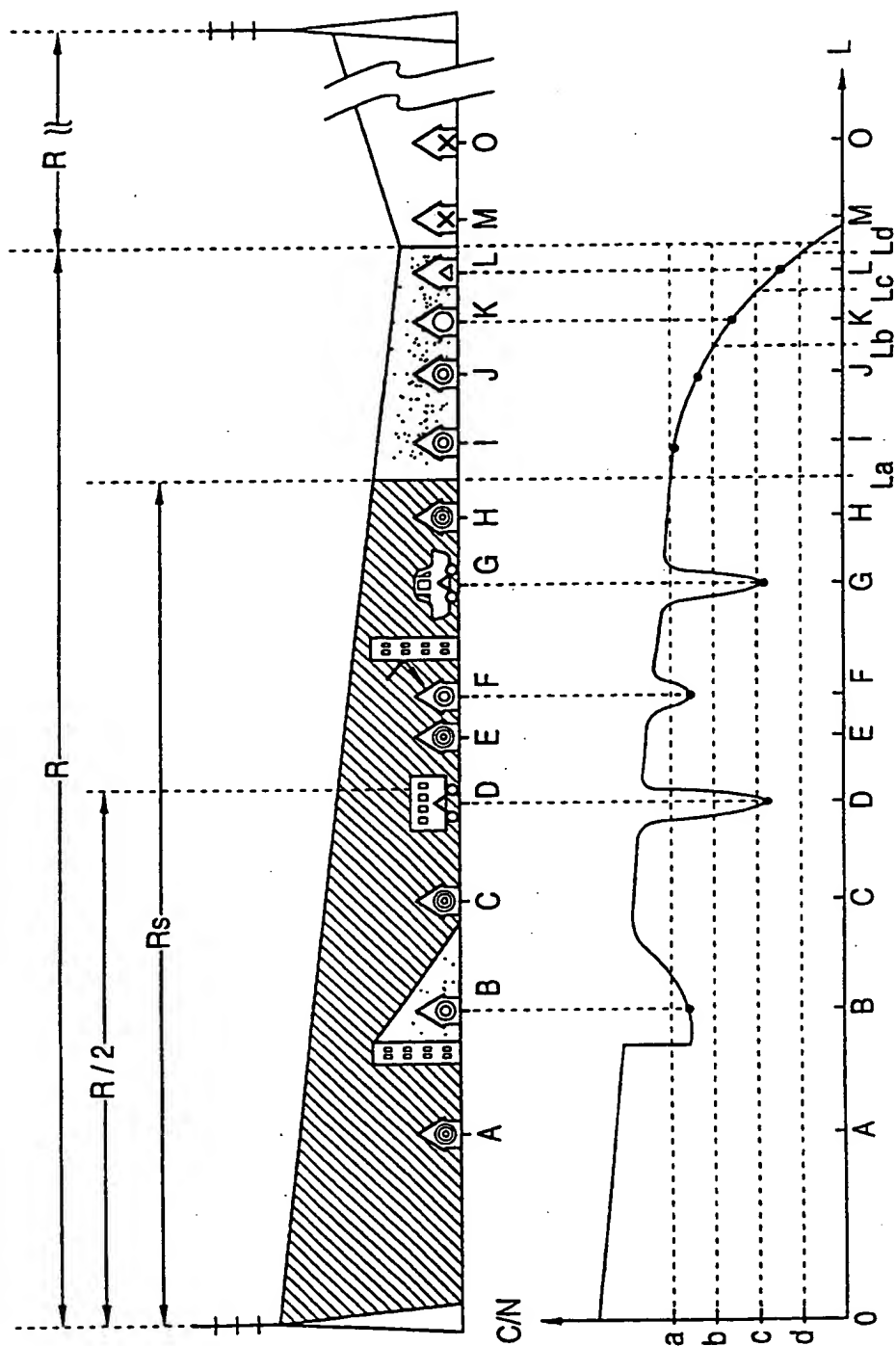


FIG. 98

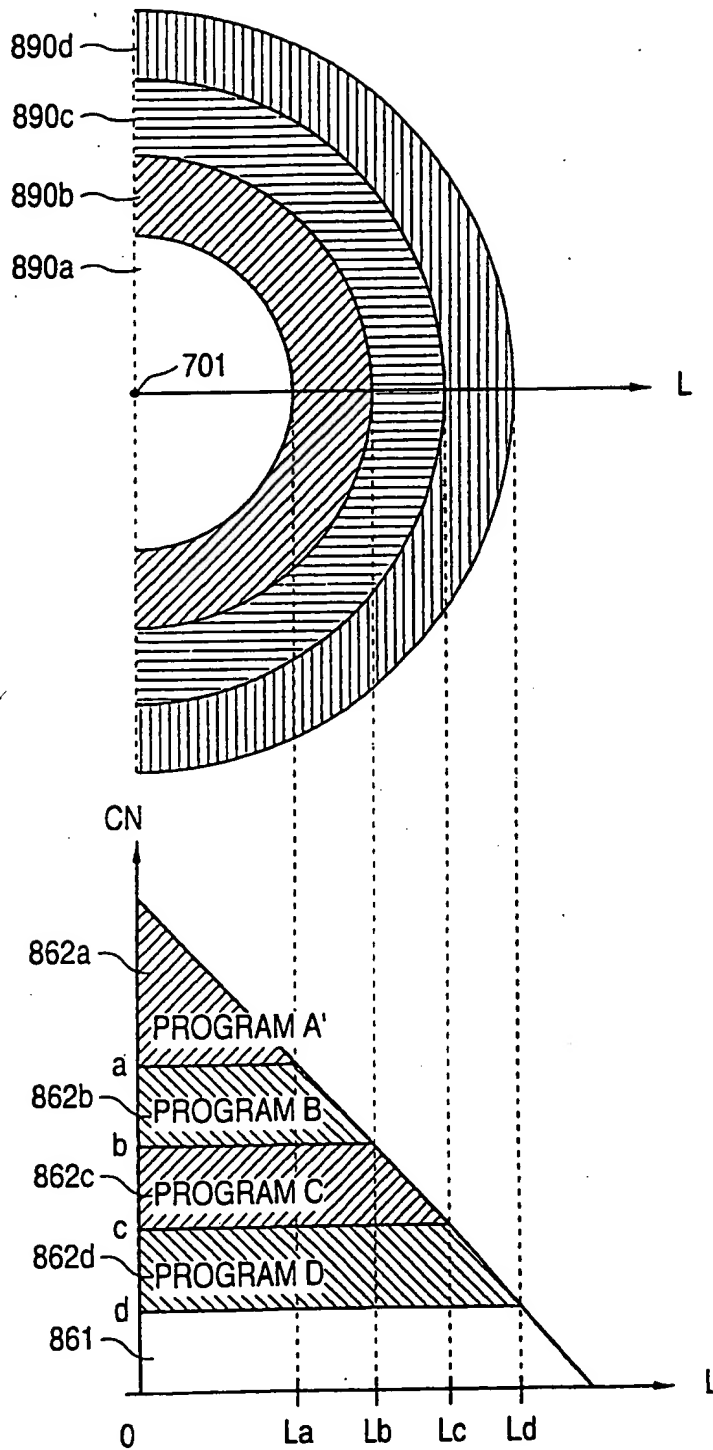


FIG. 99

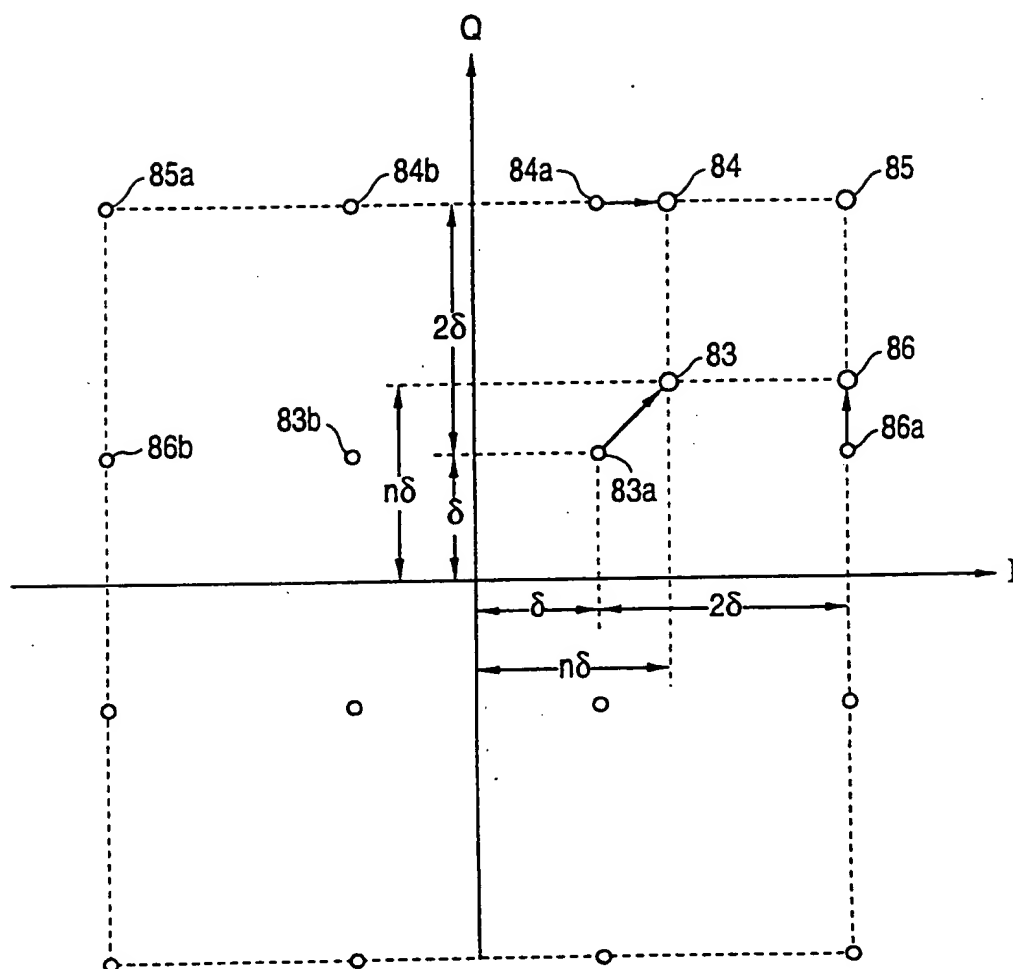


FIG. 100

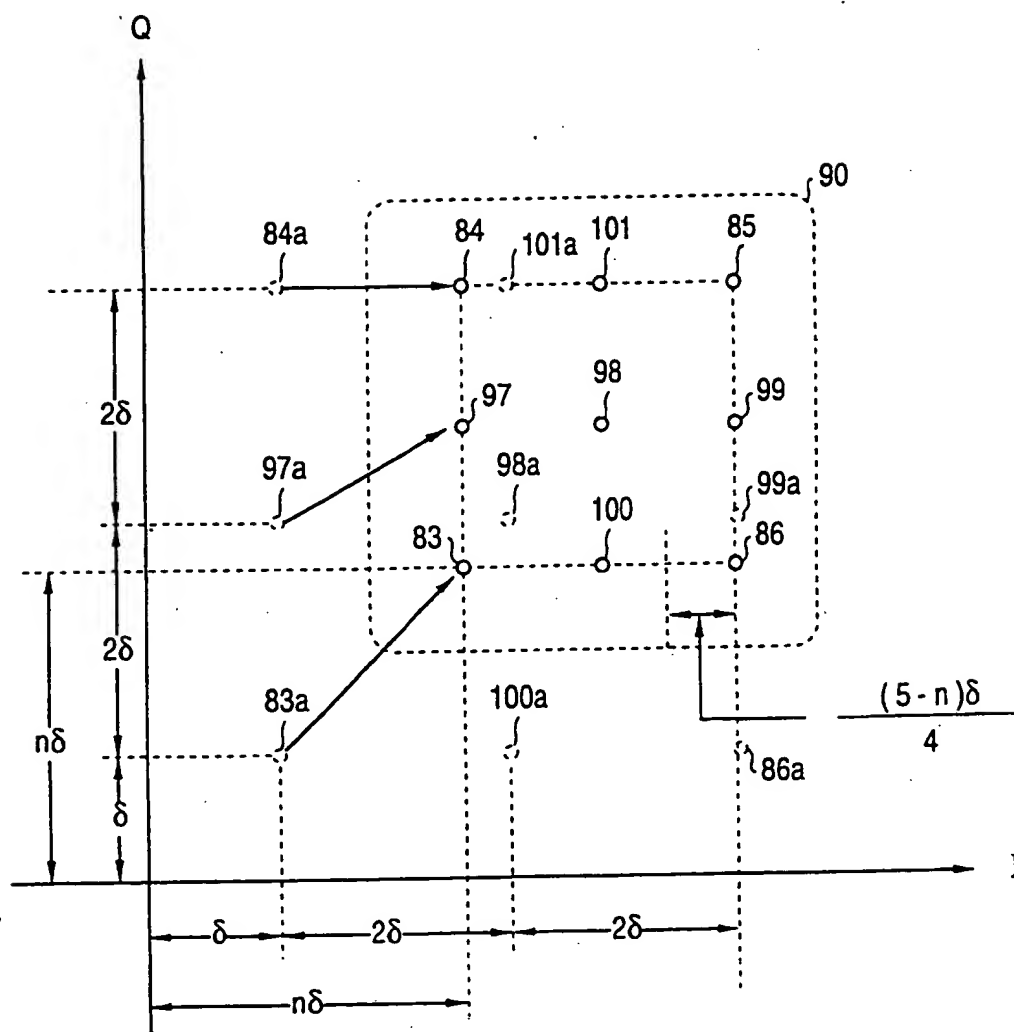


FIG. 101

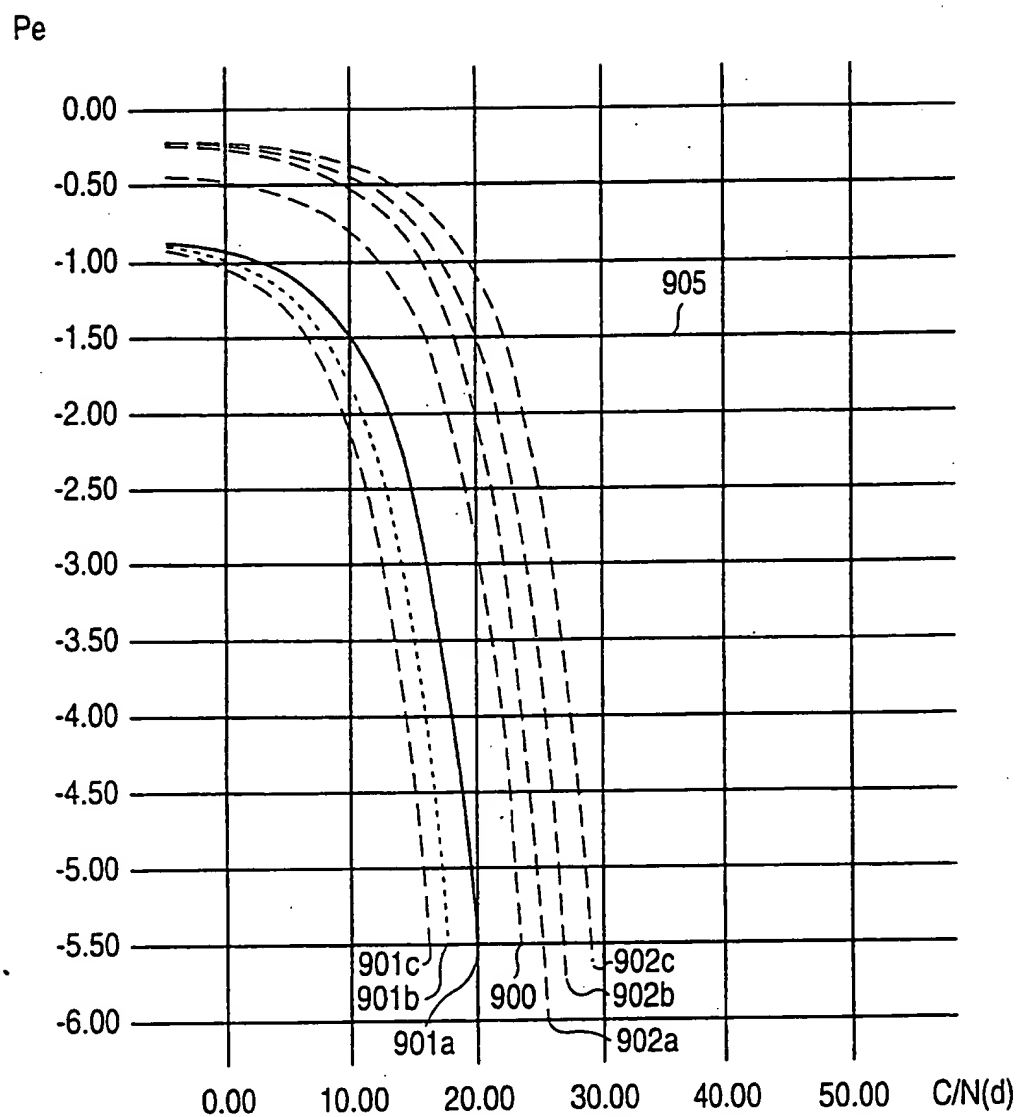


FIG. 102

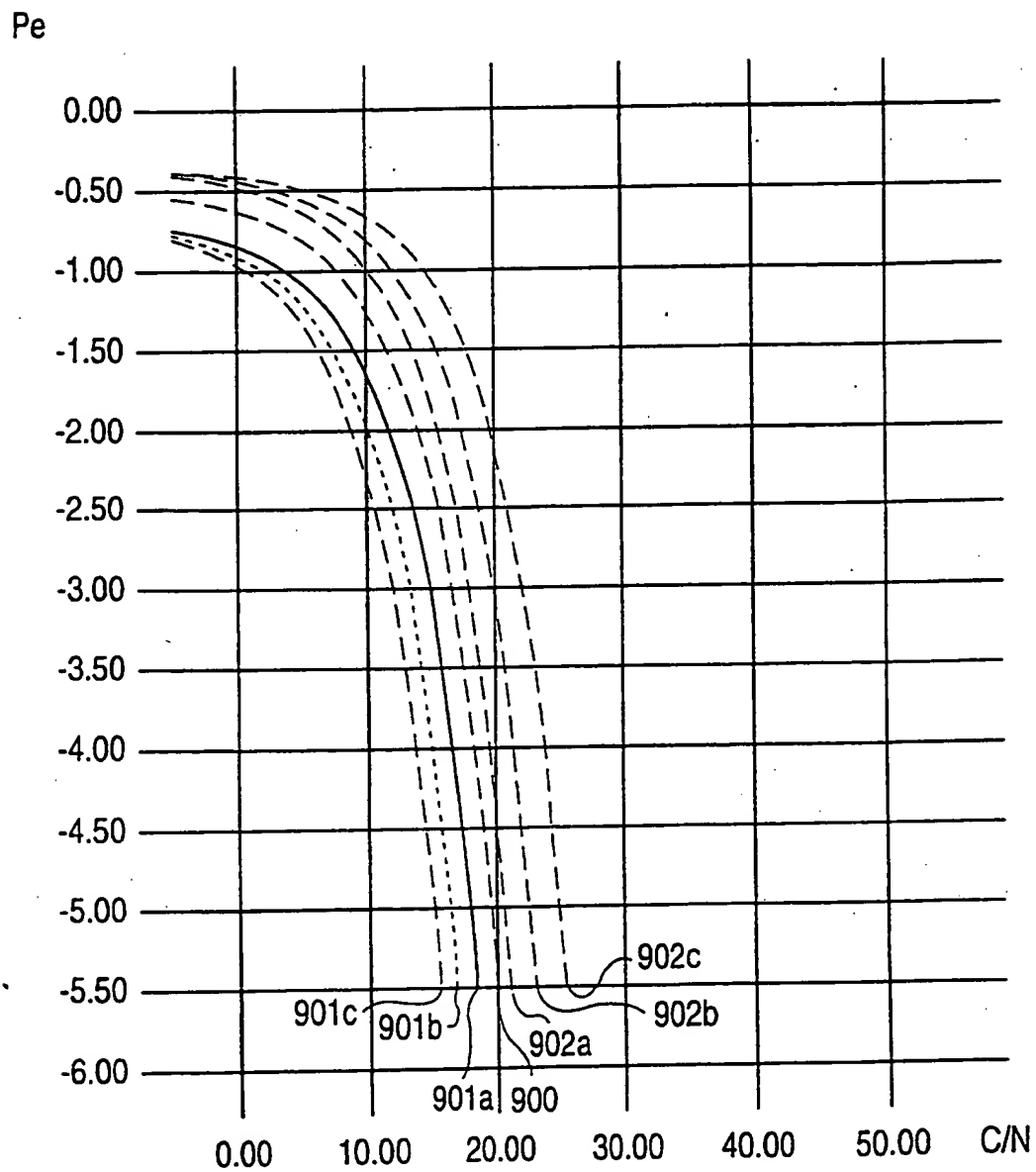


FIG. 103

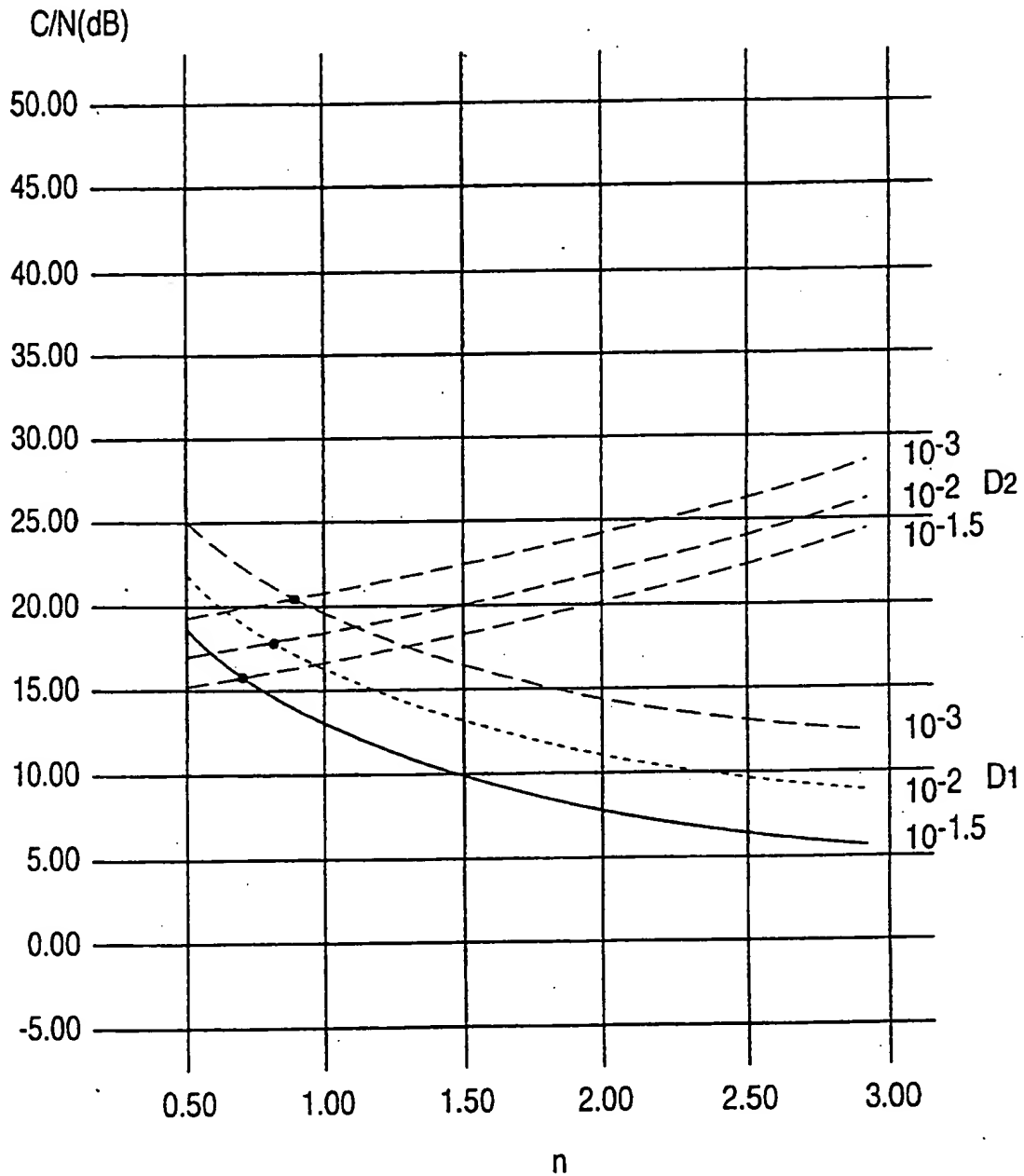


FIG. 104

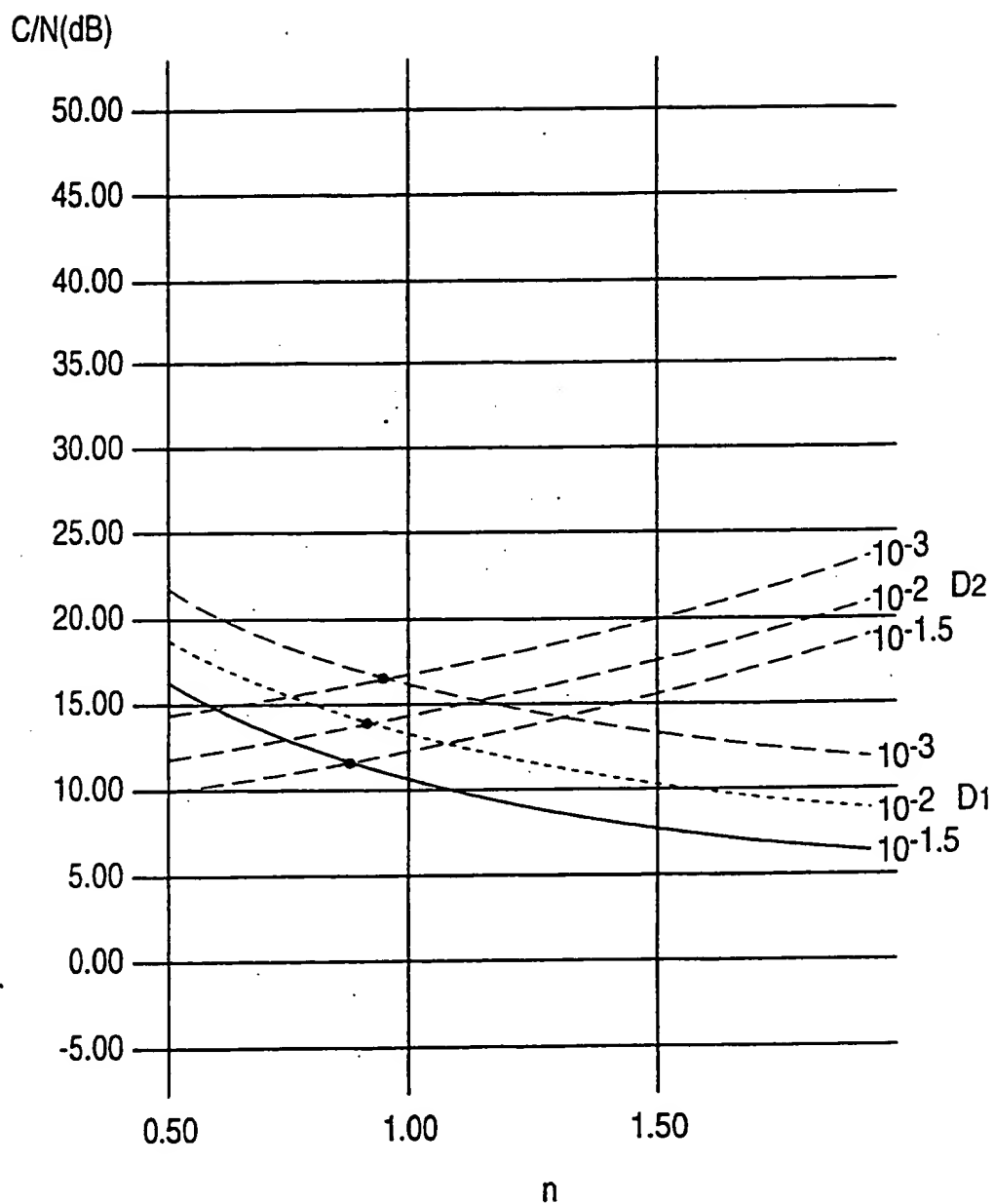


FIG. 105

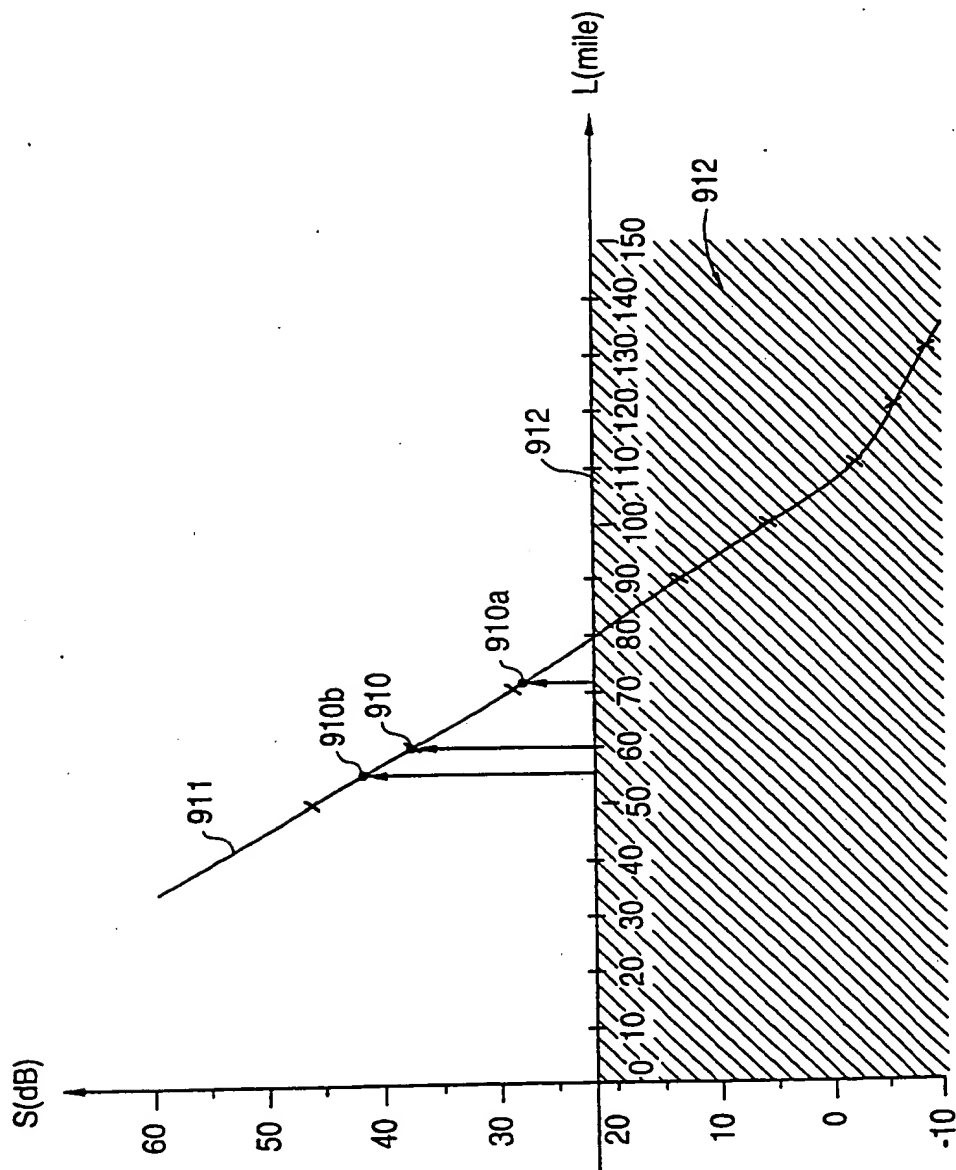


FIG. 106

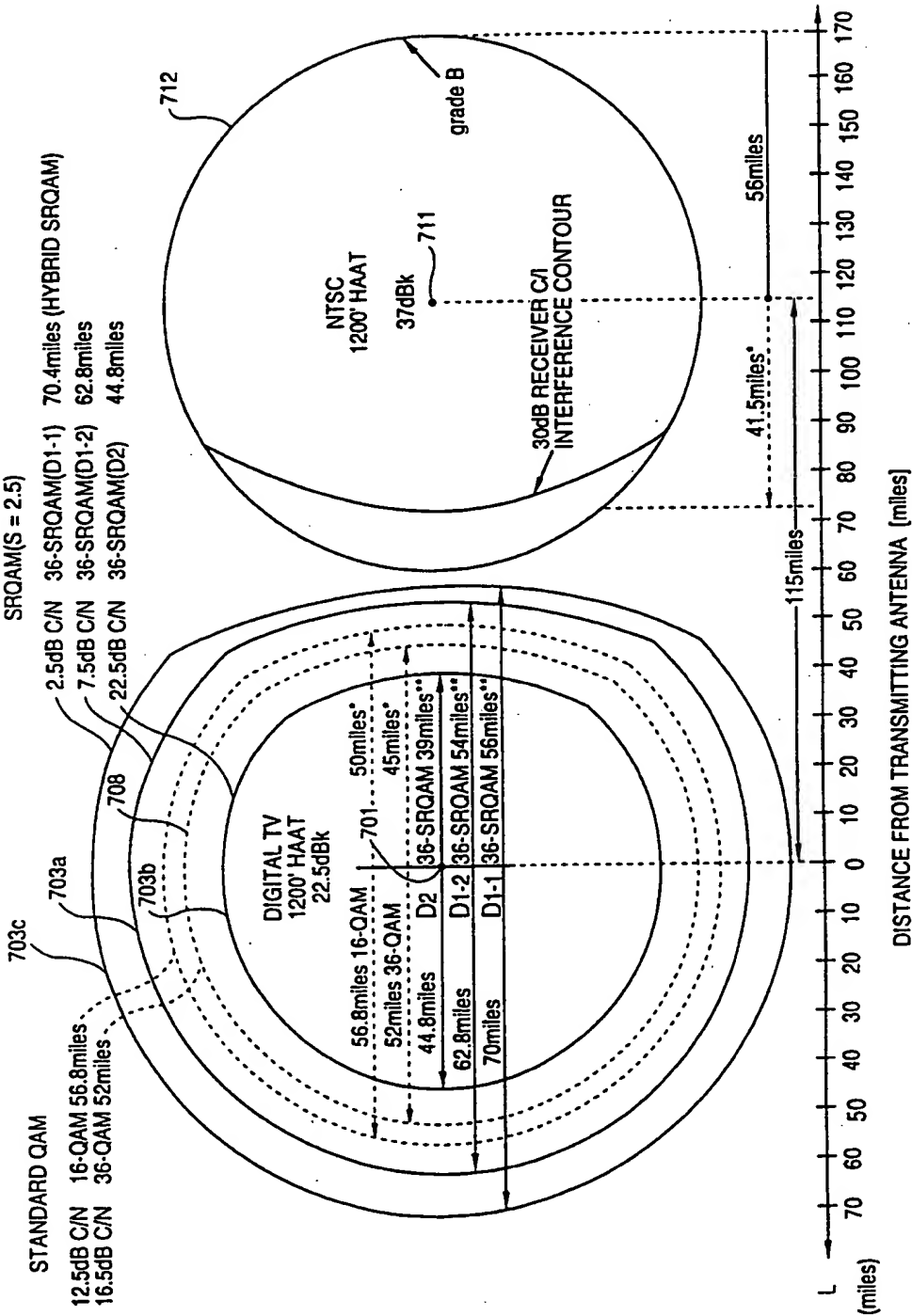


FIG. 107

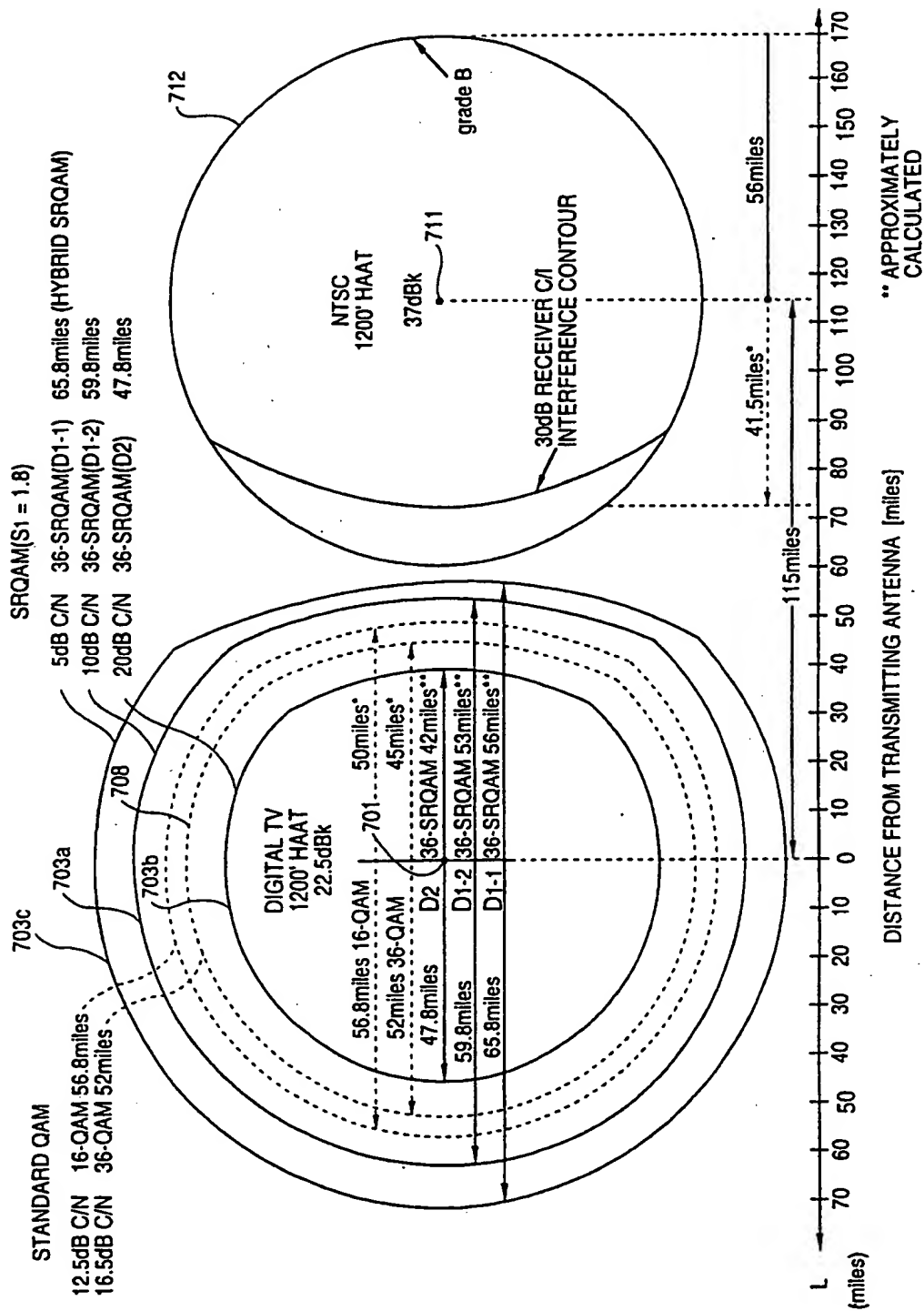


FIG. 108(a)

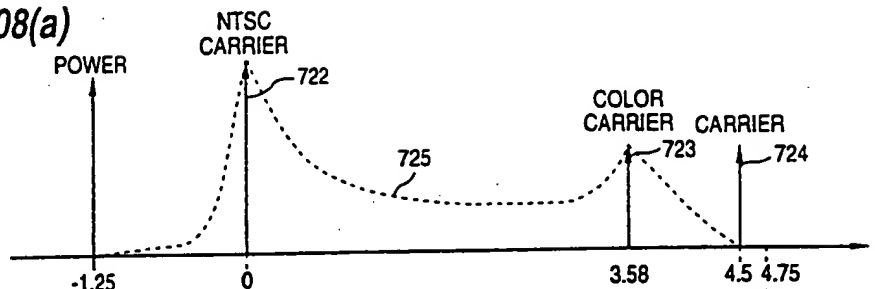


FIG. 108(b)

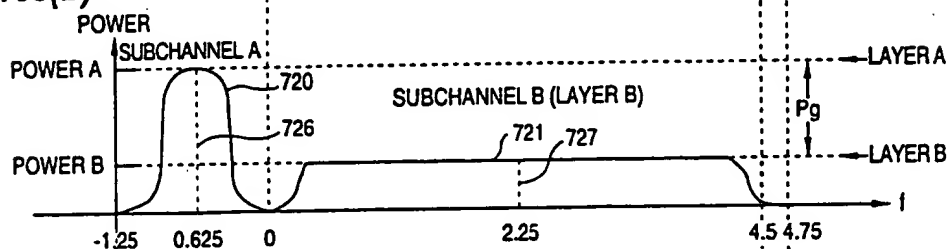


FIG. 108(c)

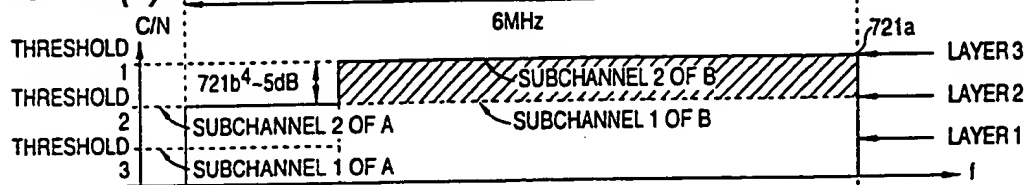


FIG. 108(d)

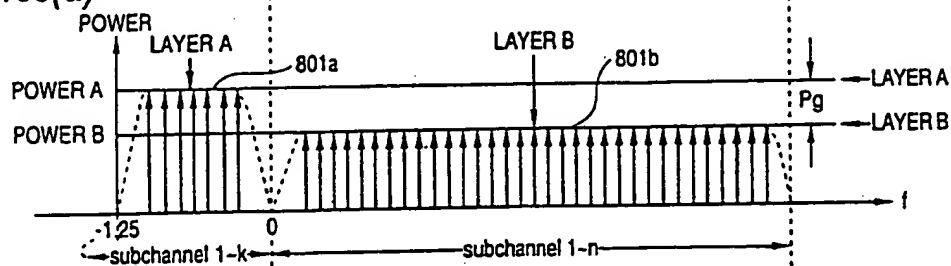


FIG. 108(e)

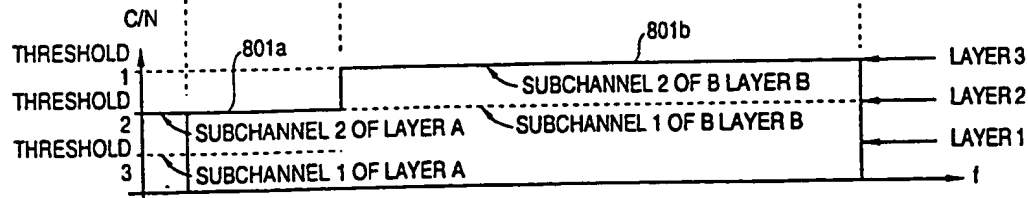
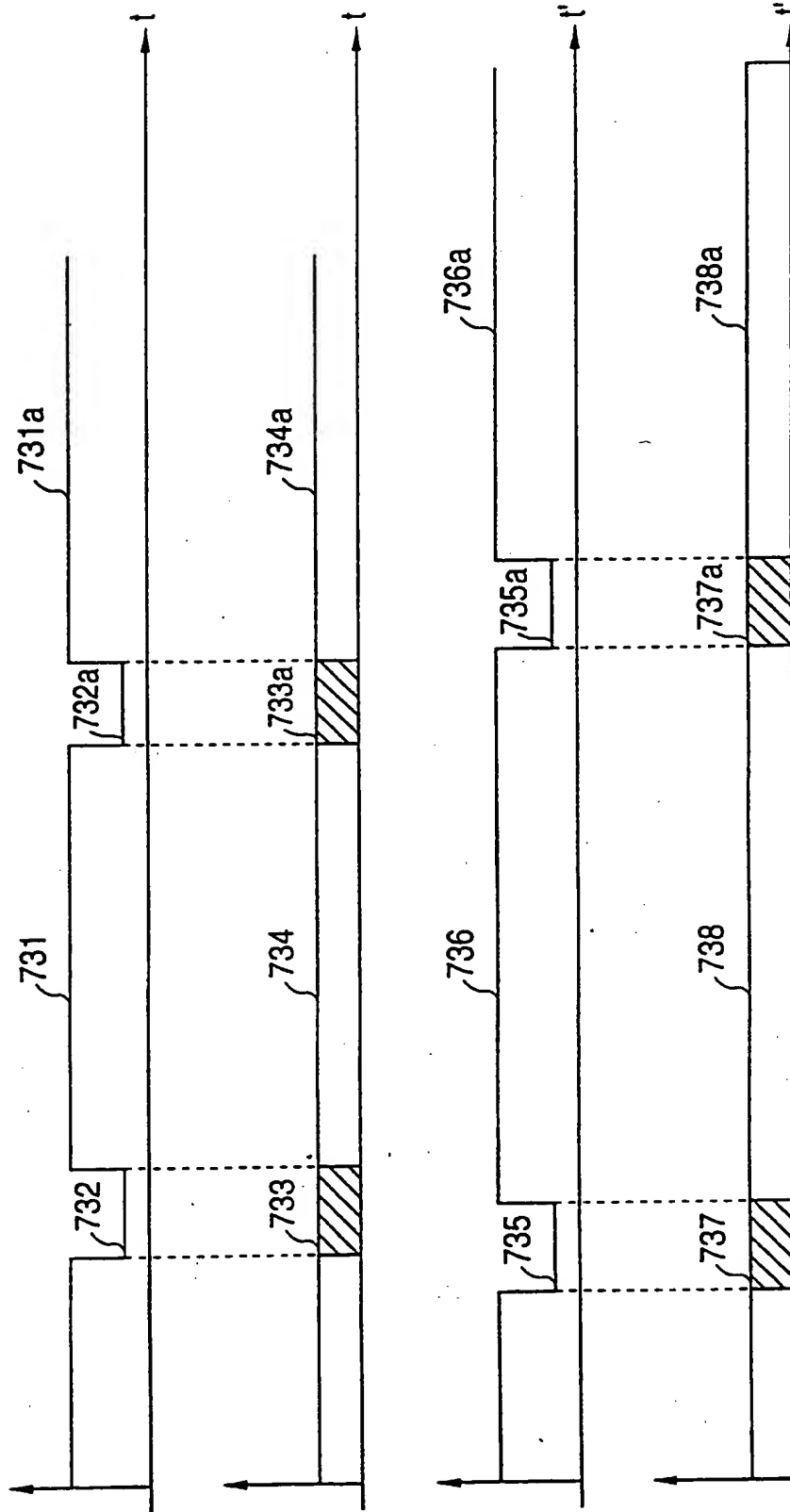


FIG. 109



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FIG. 110

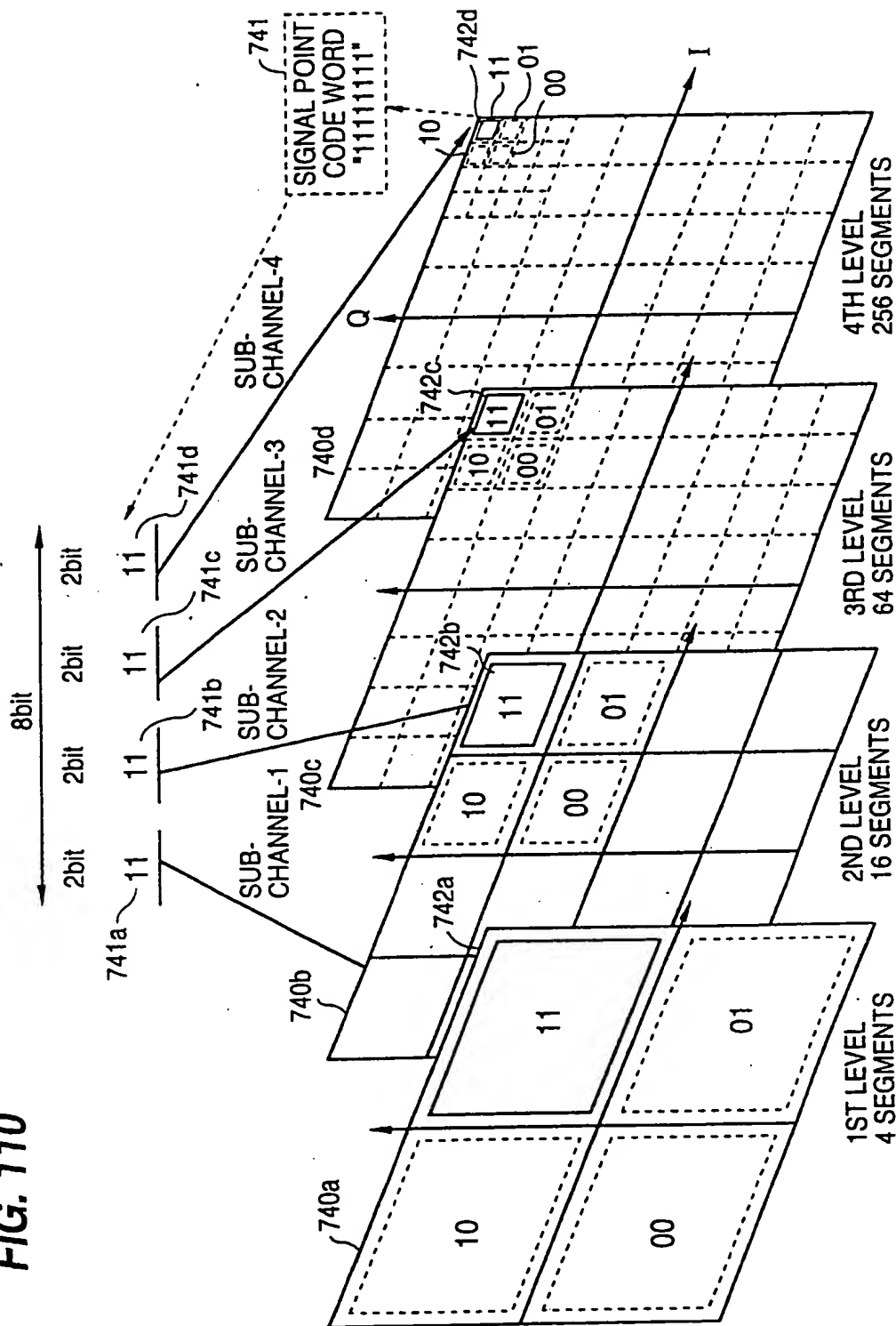
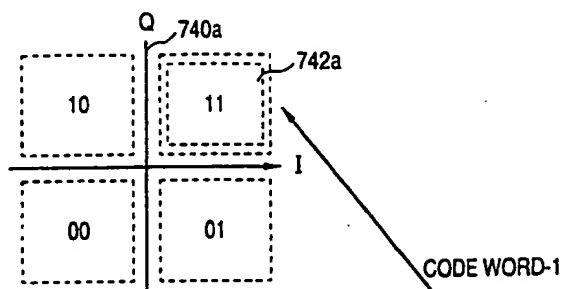
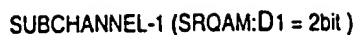
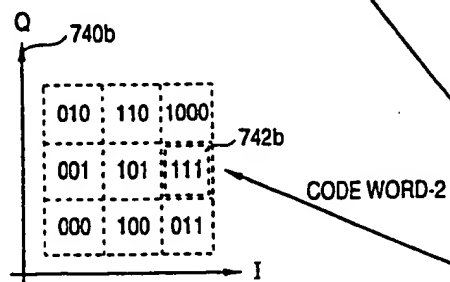


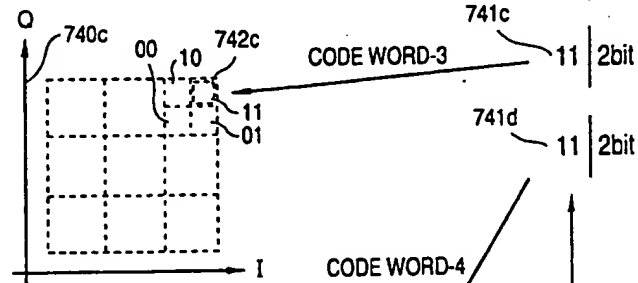
FIG. 111



SUBCHANNEL-2 (36-SRQAM:D2 = 3bit + 1/8bit)



SUBCHANNEL-3 (144-SRQAM:D3 = 2bit)



SUBCHANNEL-4 (576-SRQAM:D4 = 2bit)

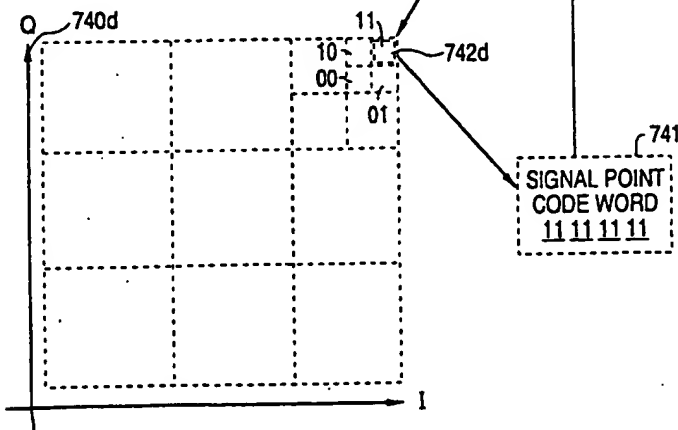
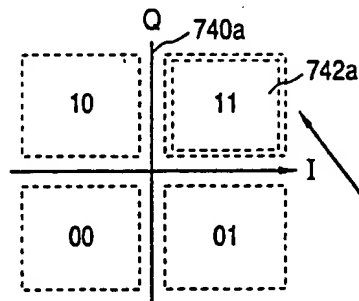
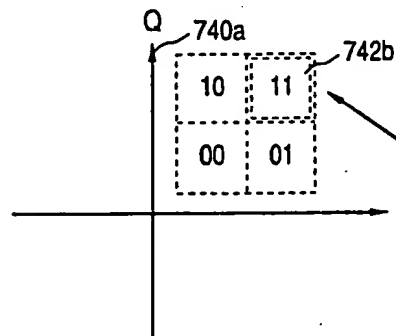


FIG. 112

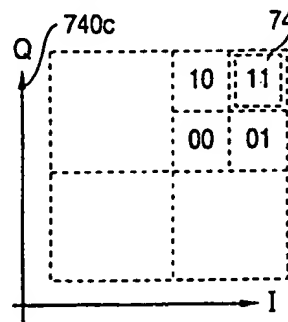
SUBCHANNEL-1 (SRQAM:D1 = 2bit)



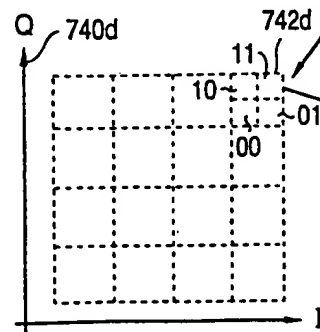
SUBCHANNEL-2 (16-SRQAM:D2 = 2bit)



SUBCHANNEL-3 (64-SRQAM:D3 = 2bit)



SUBCHANNEL-4 (256-SRQAM:D4 = 2bit)



CODE WORD-1

CODE WORD-2

CODE WORD-3

CODE WORD-4

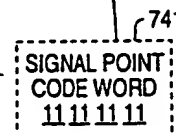
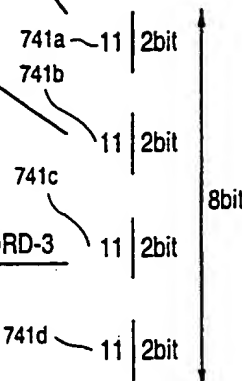


FIG. 113

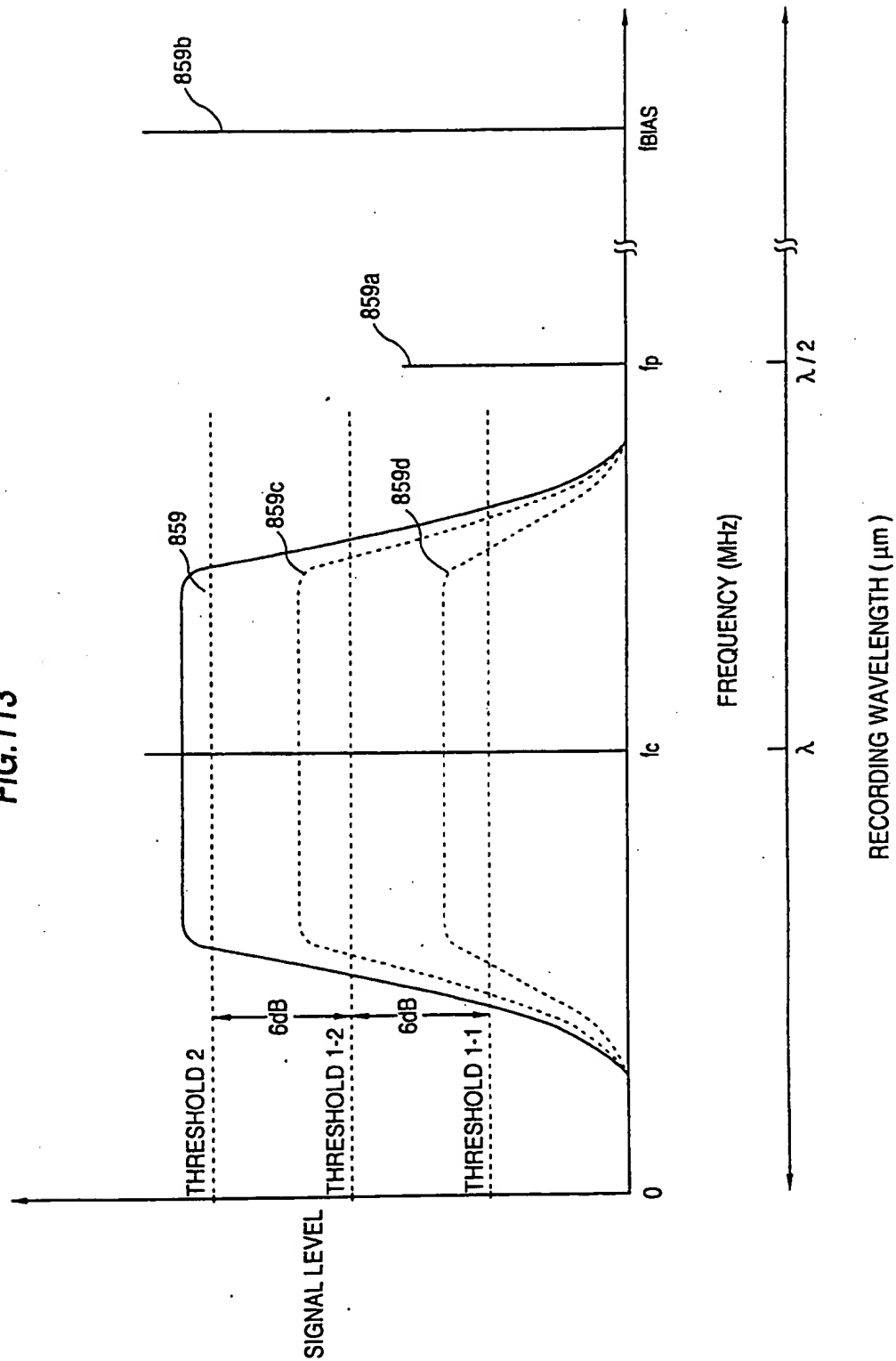


FIG. 114

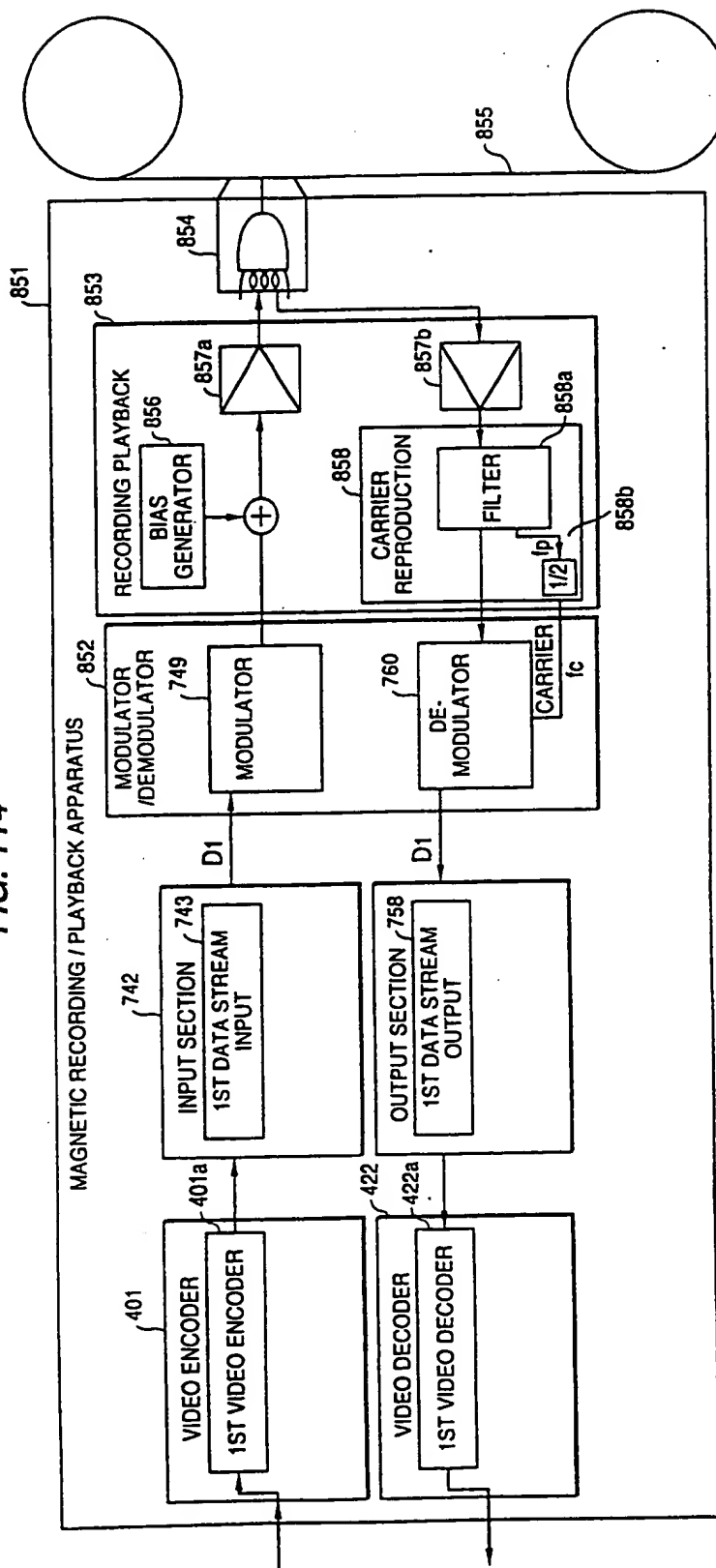


FIG. 115

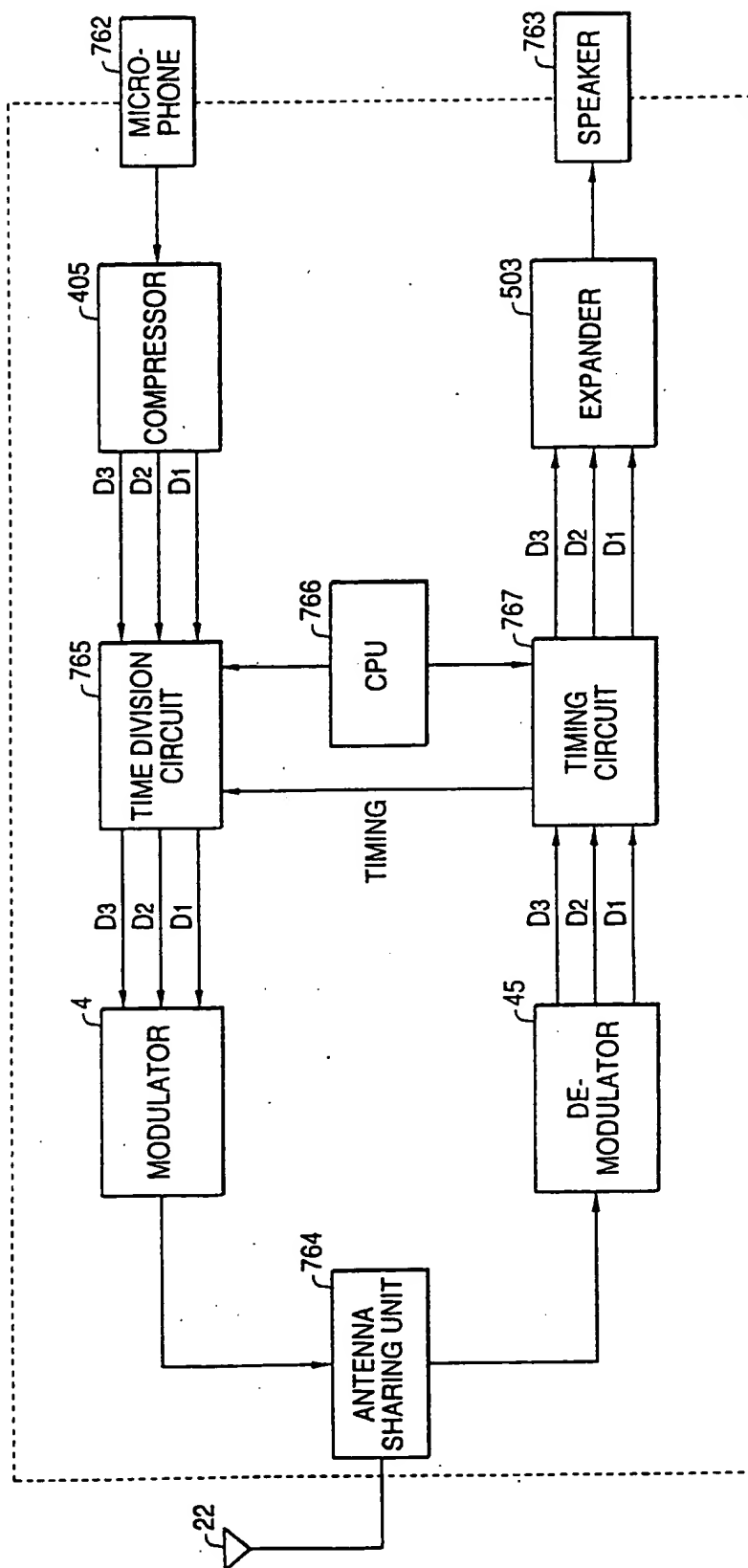


FIG. 116

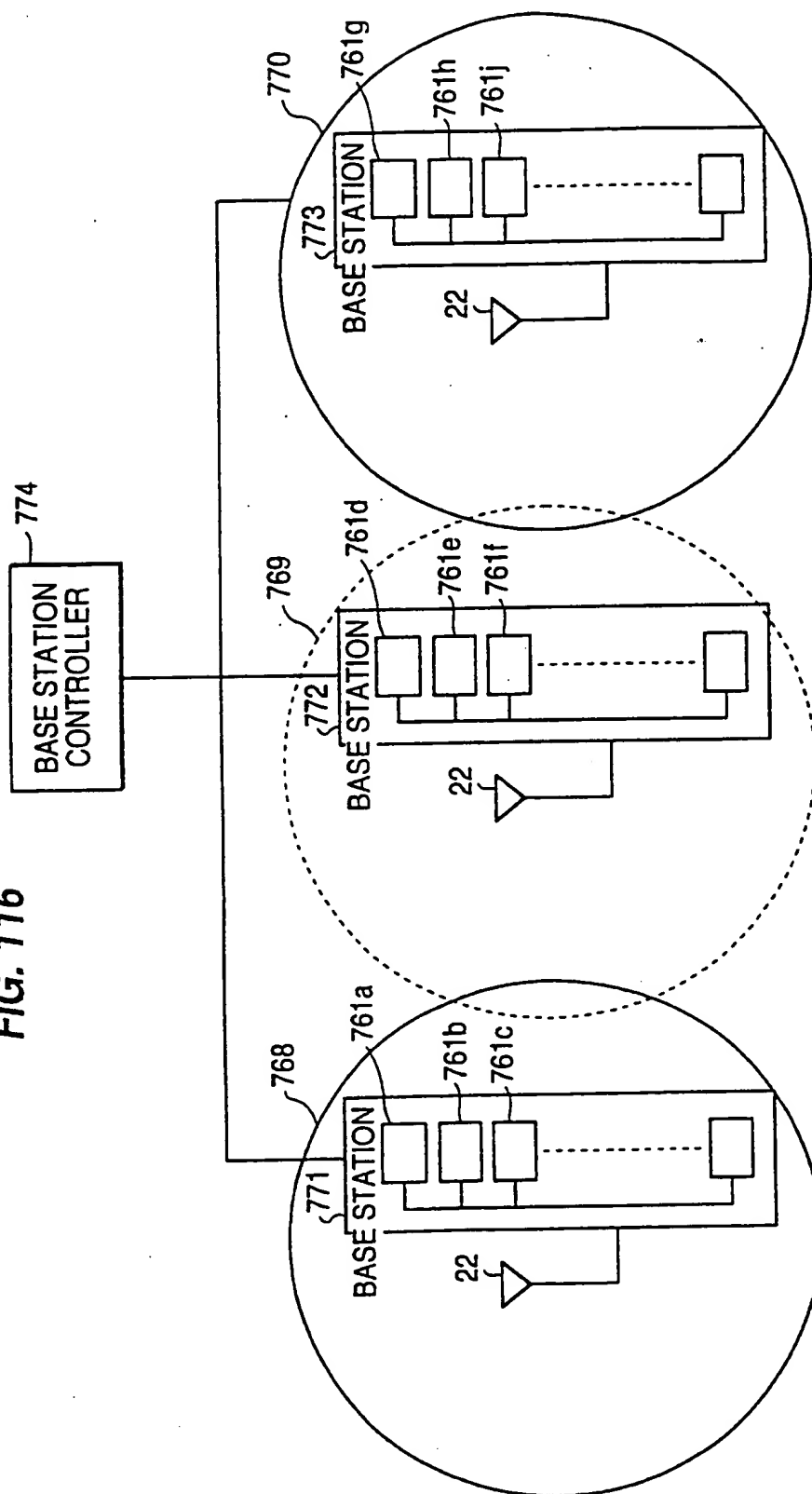


FIG. 117

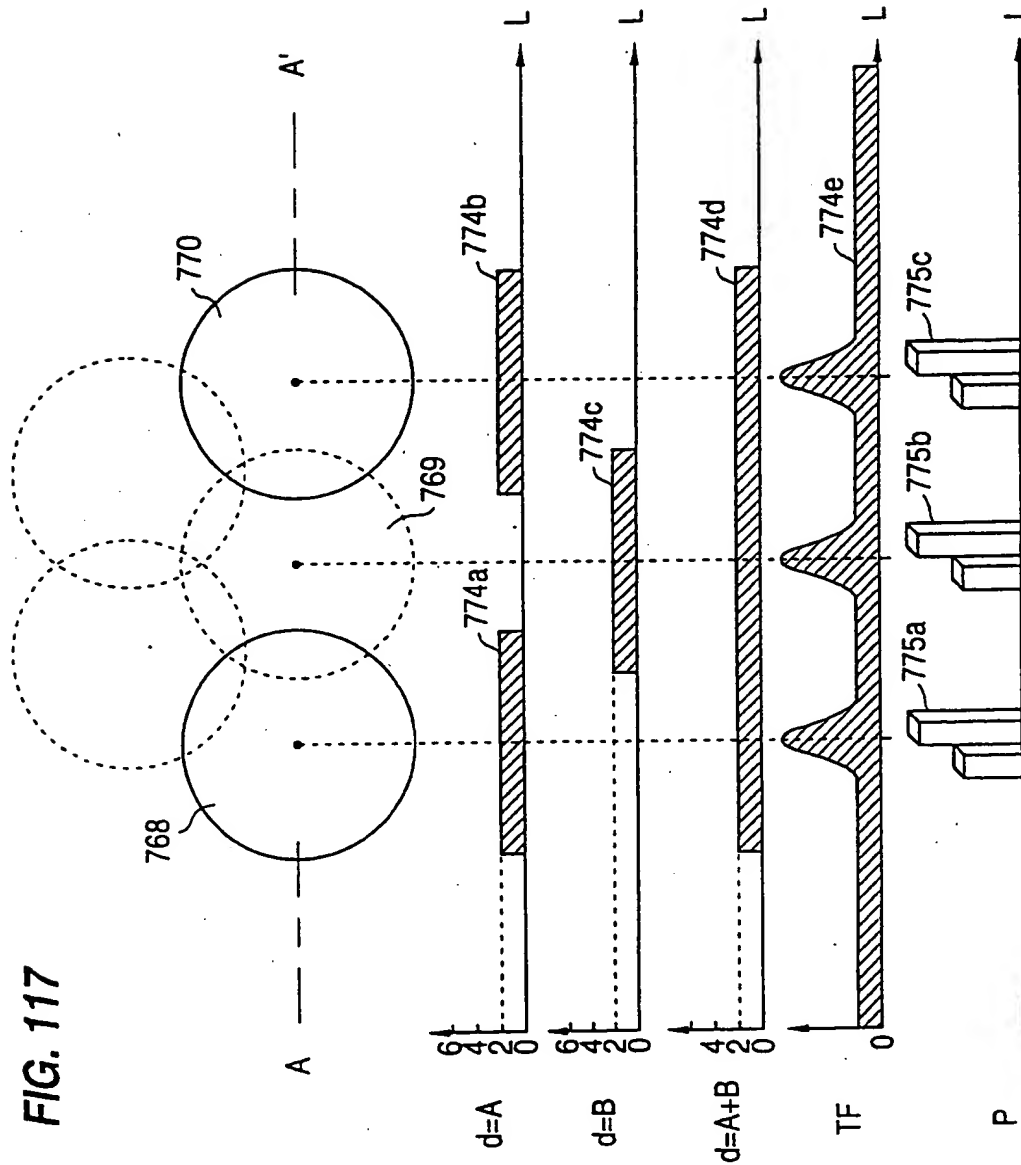
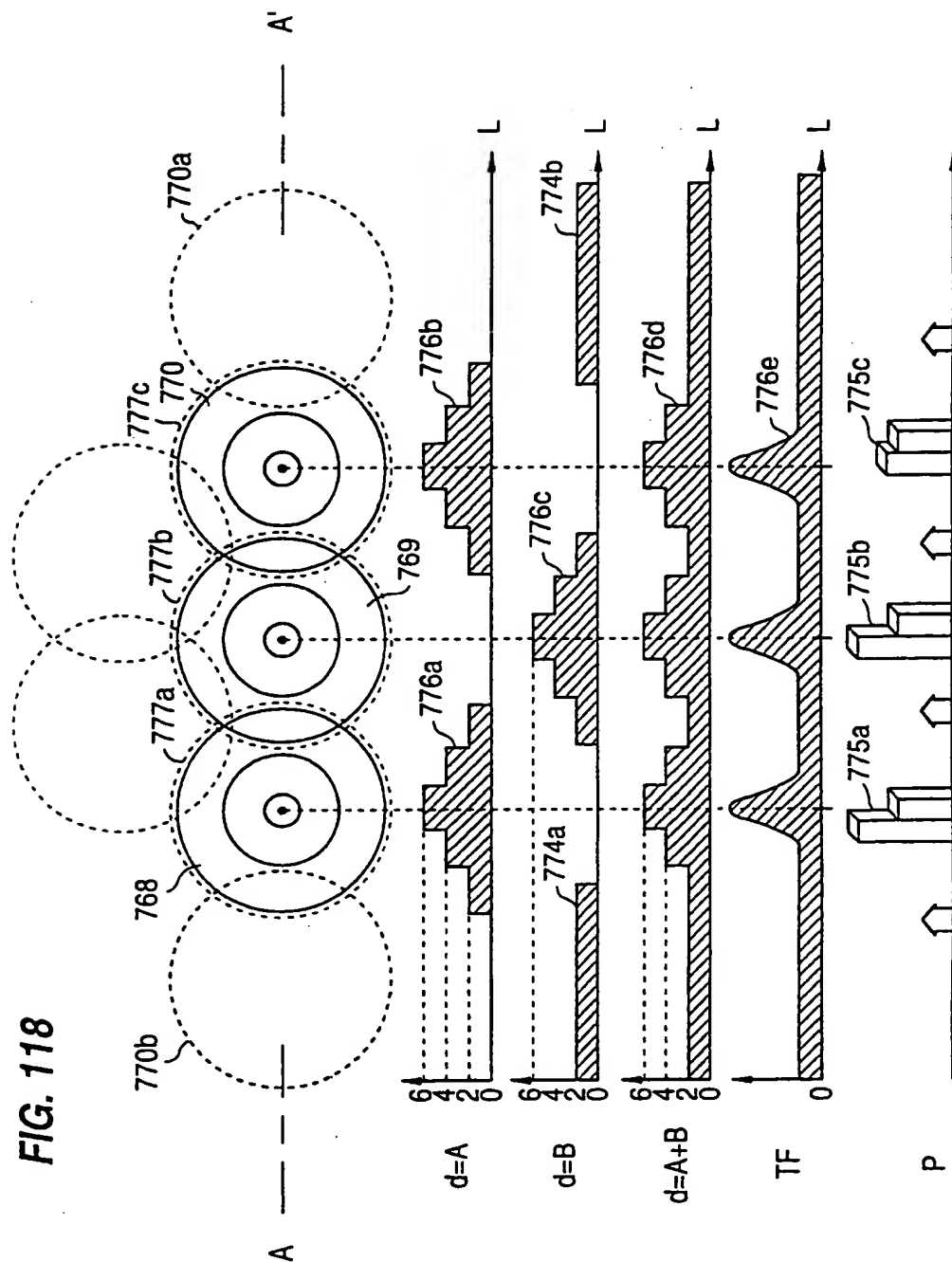


FIG. 118



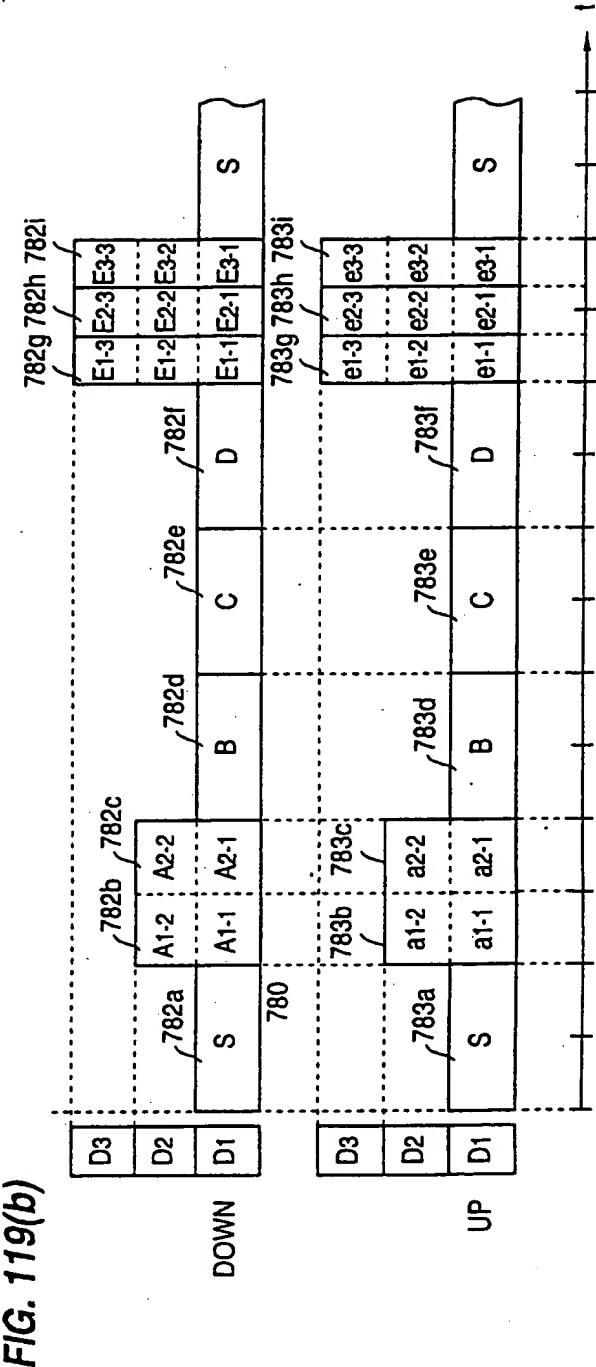
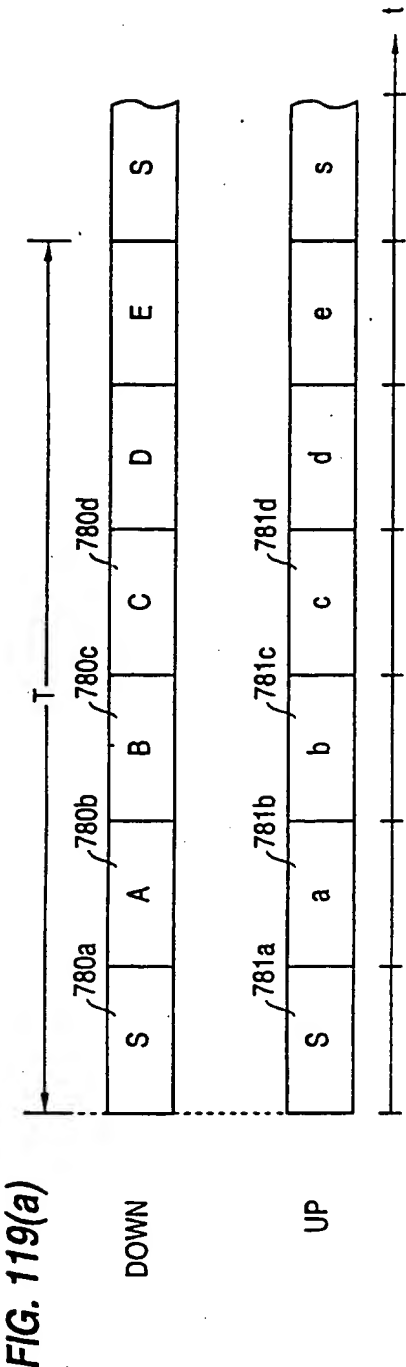


FIG. 120(a)

FIG. 121

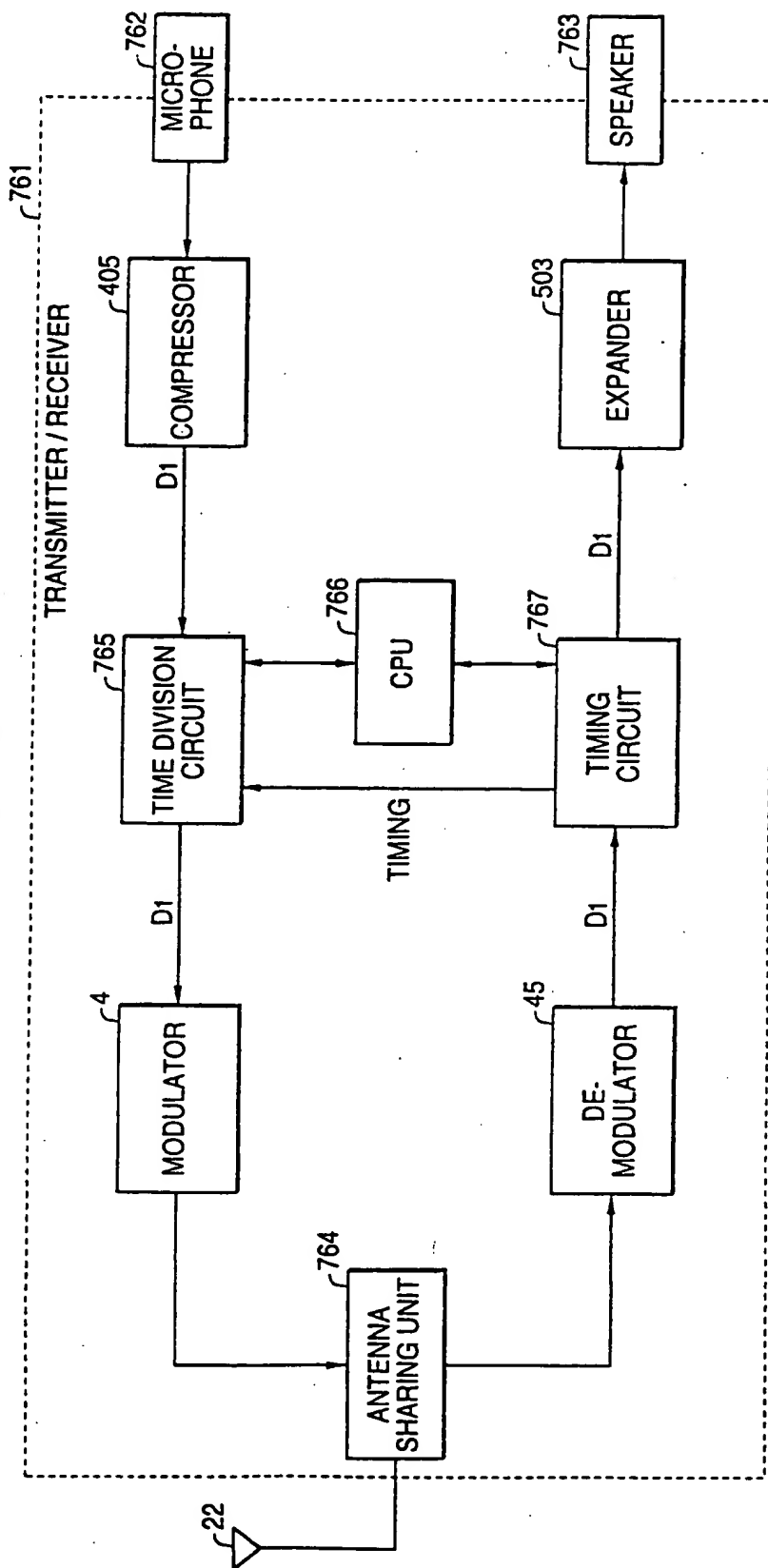


FIG. 122

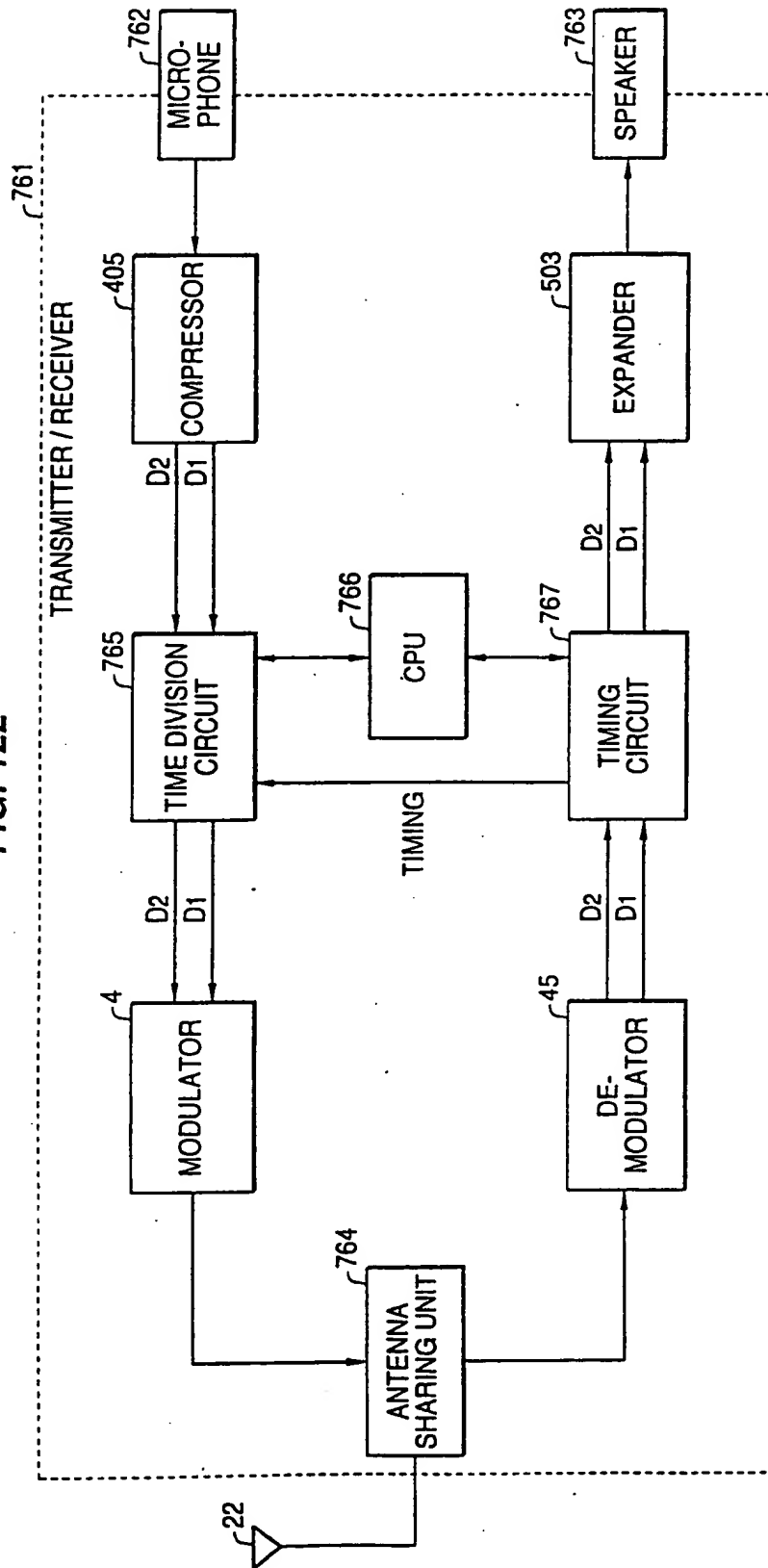
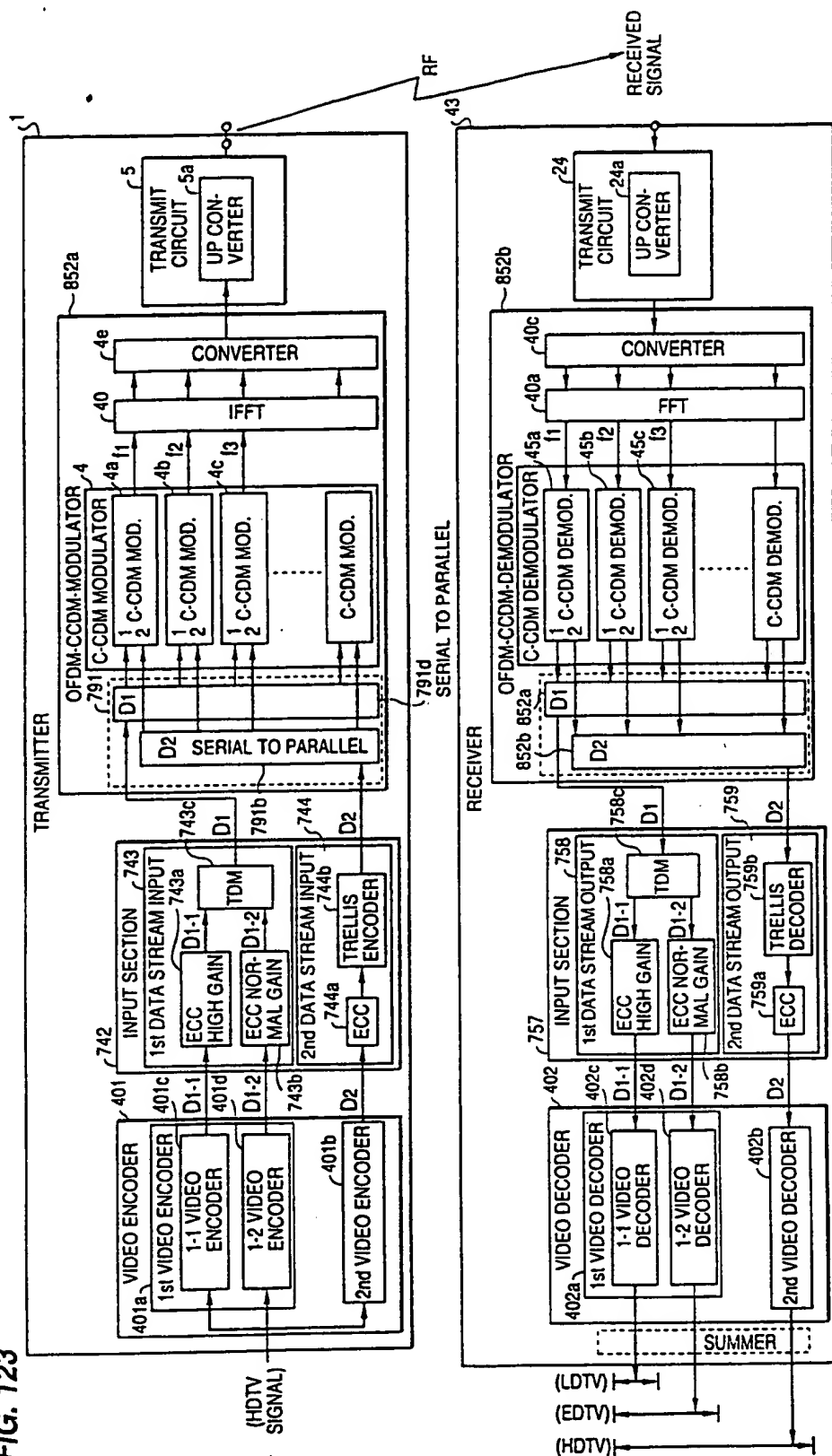


FIG. 123



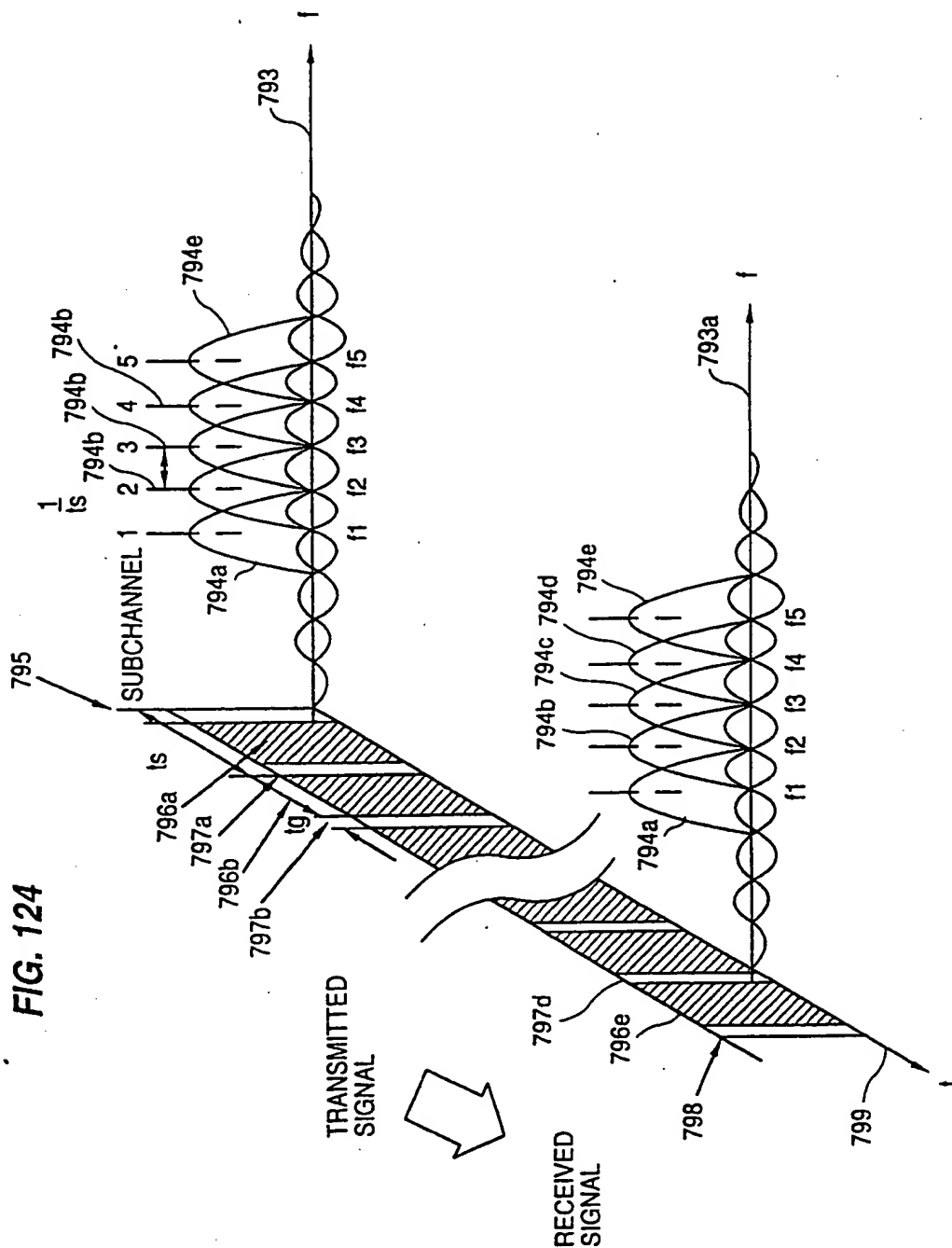


FIG. 125(a)

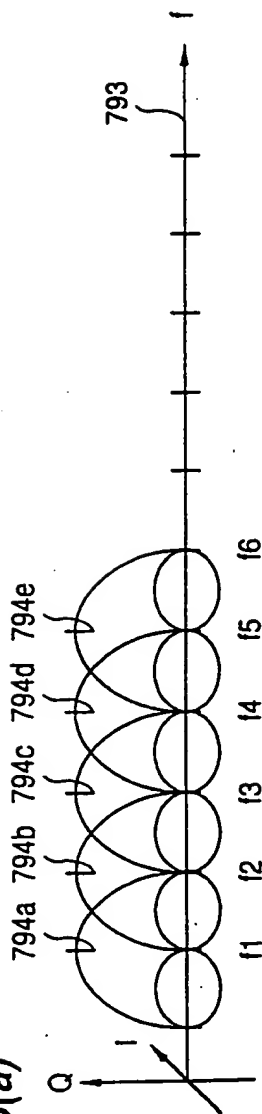
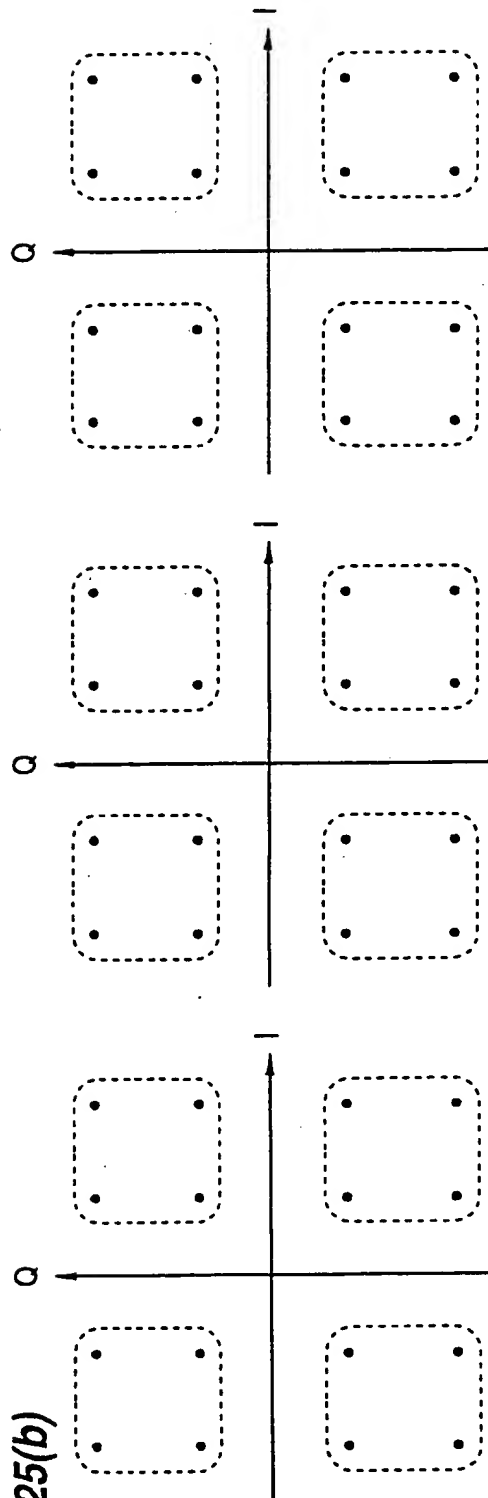


FIG. 125(b)



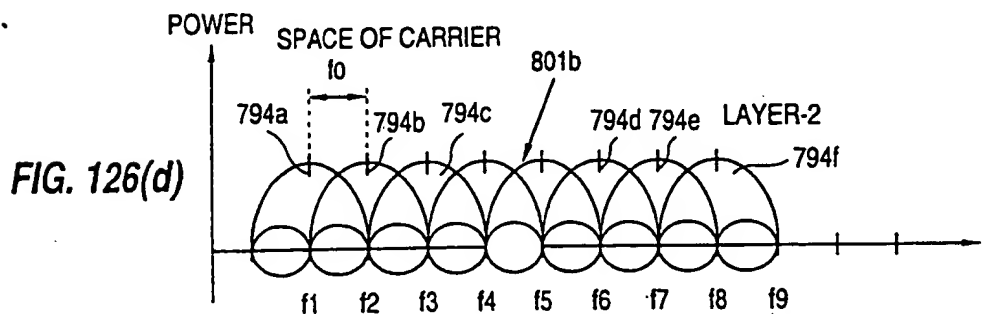
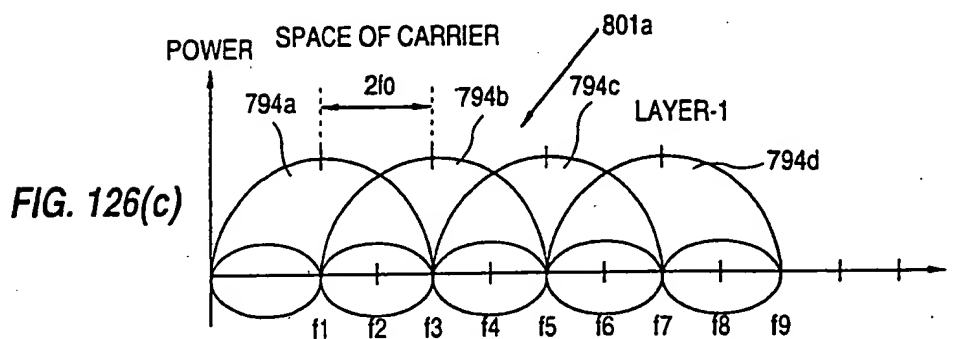
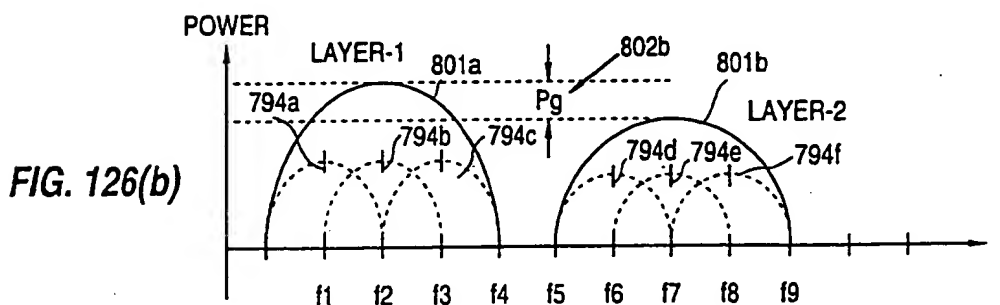
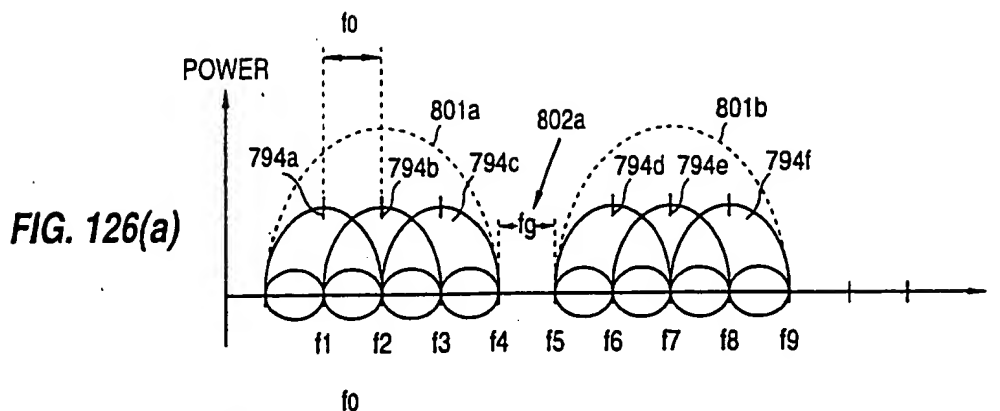


FIG. 127

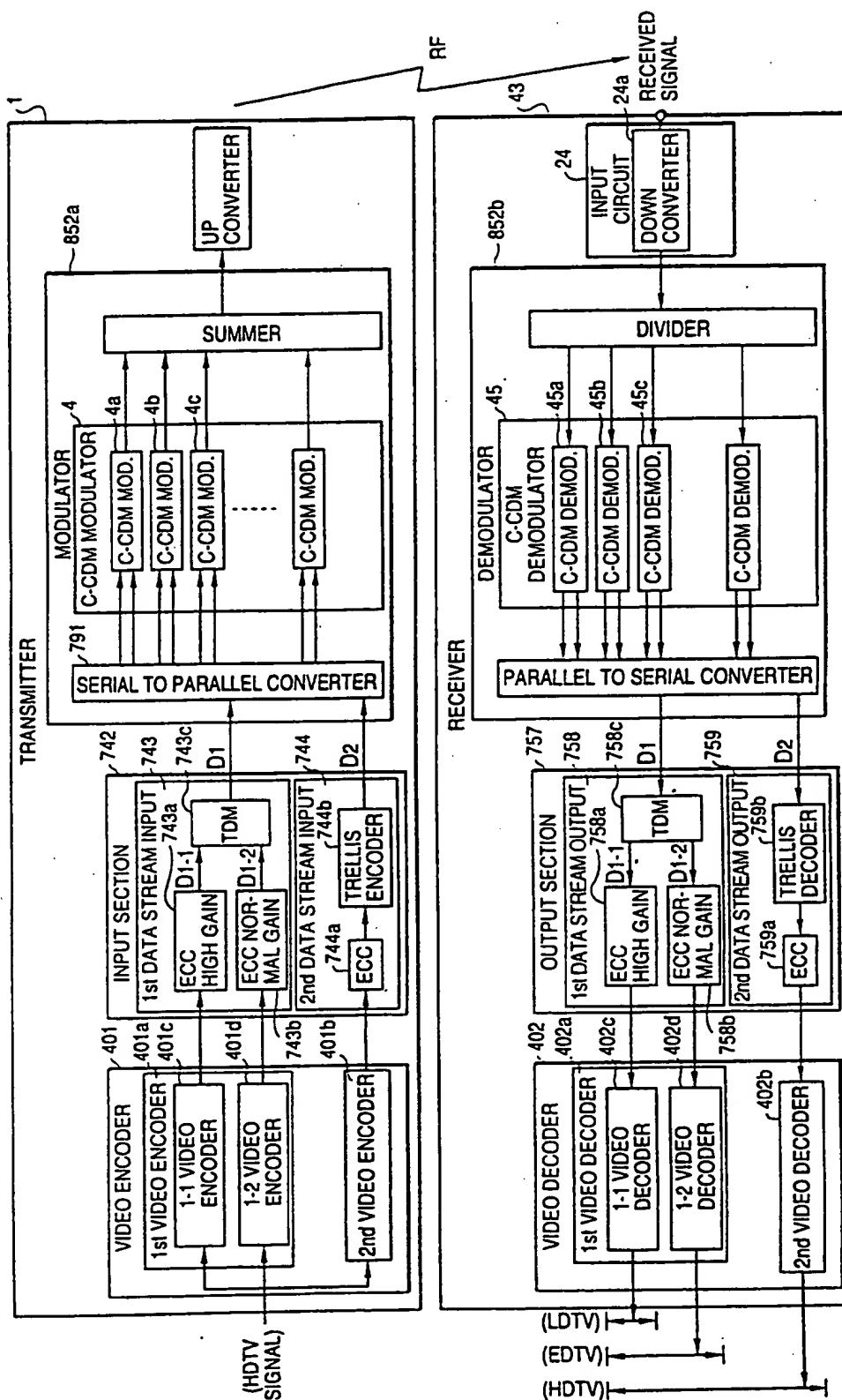


FIG. 128(a)

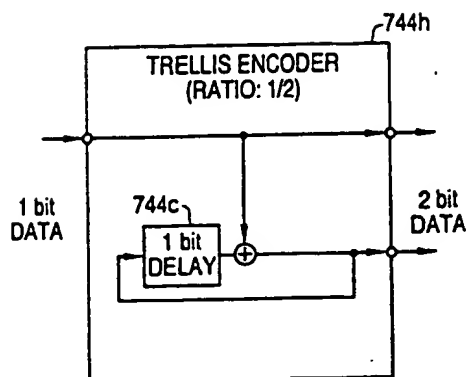


FIG. 128(d)

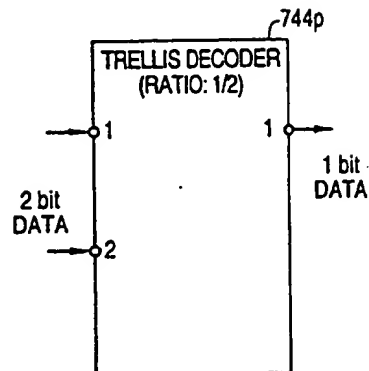


FIG. 128(b)

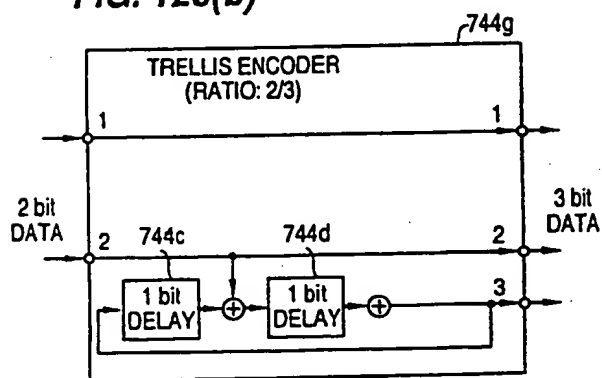


FIG. 128(e)

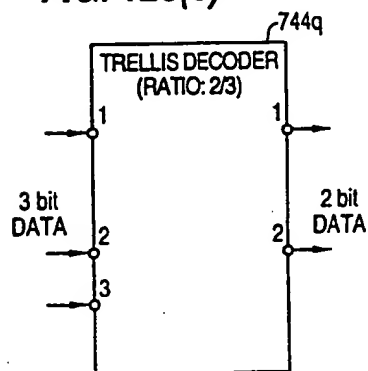


FIG. 128(c)

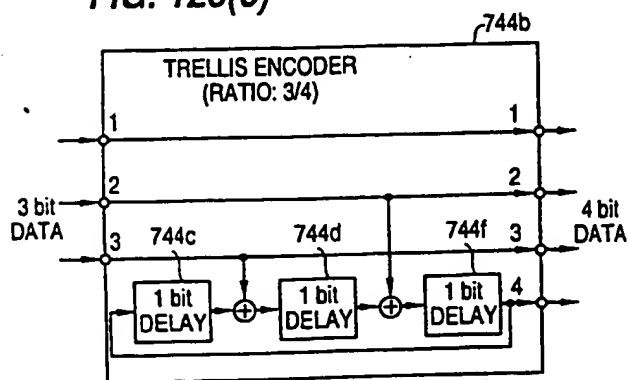


FIG. 128(f)

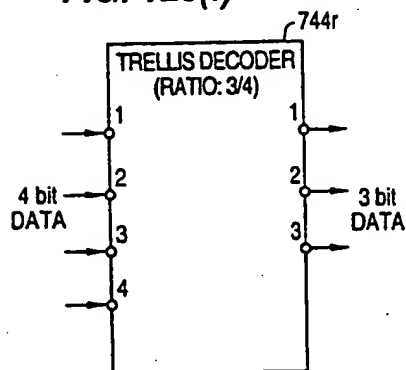


FIG. 129

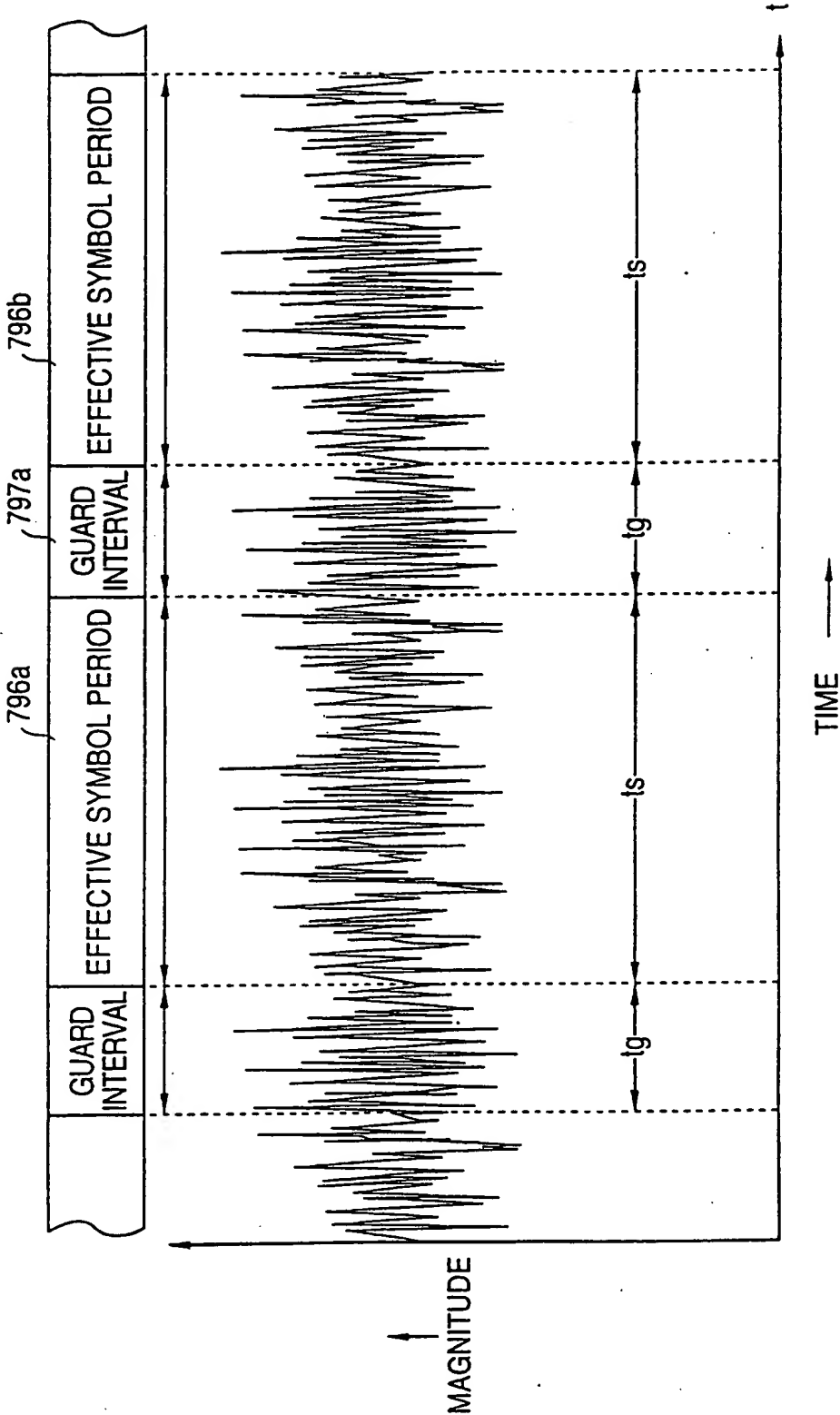


FIG. 130

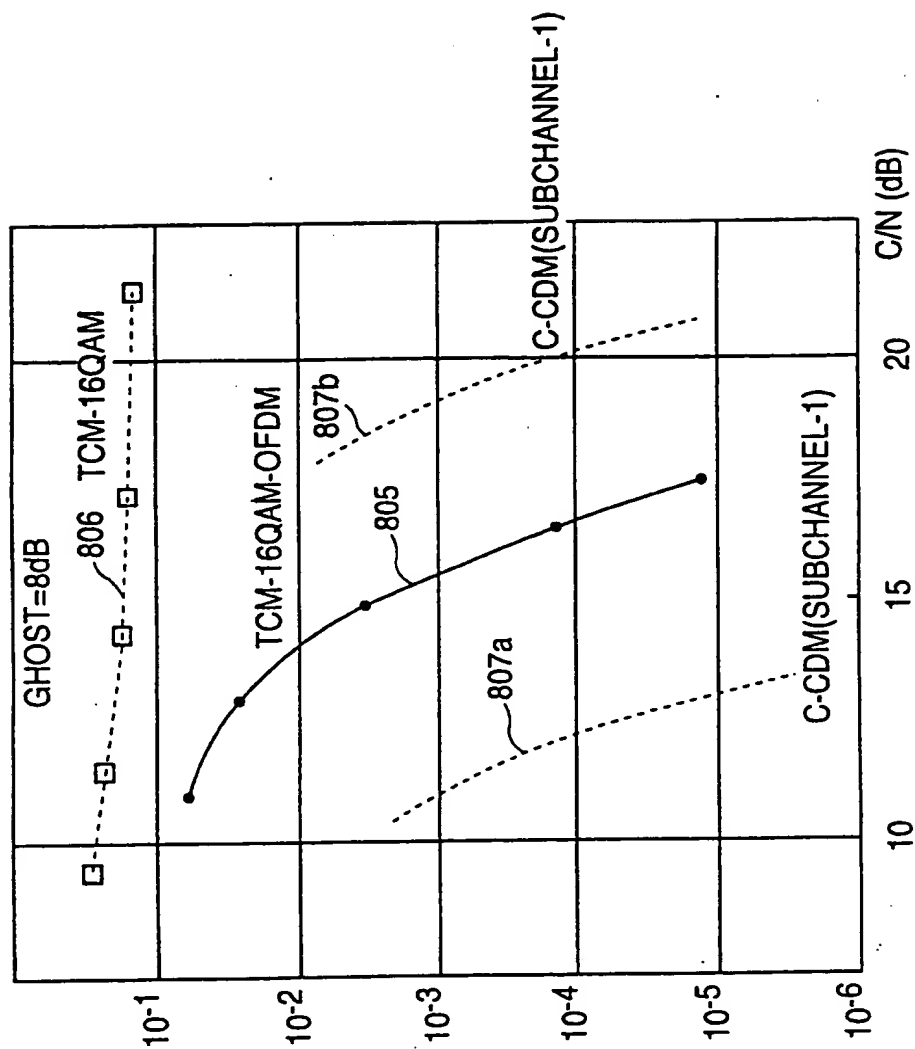


FIG. 131

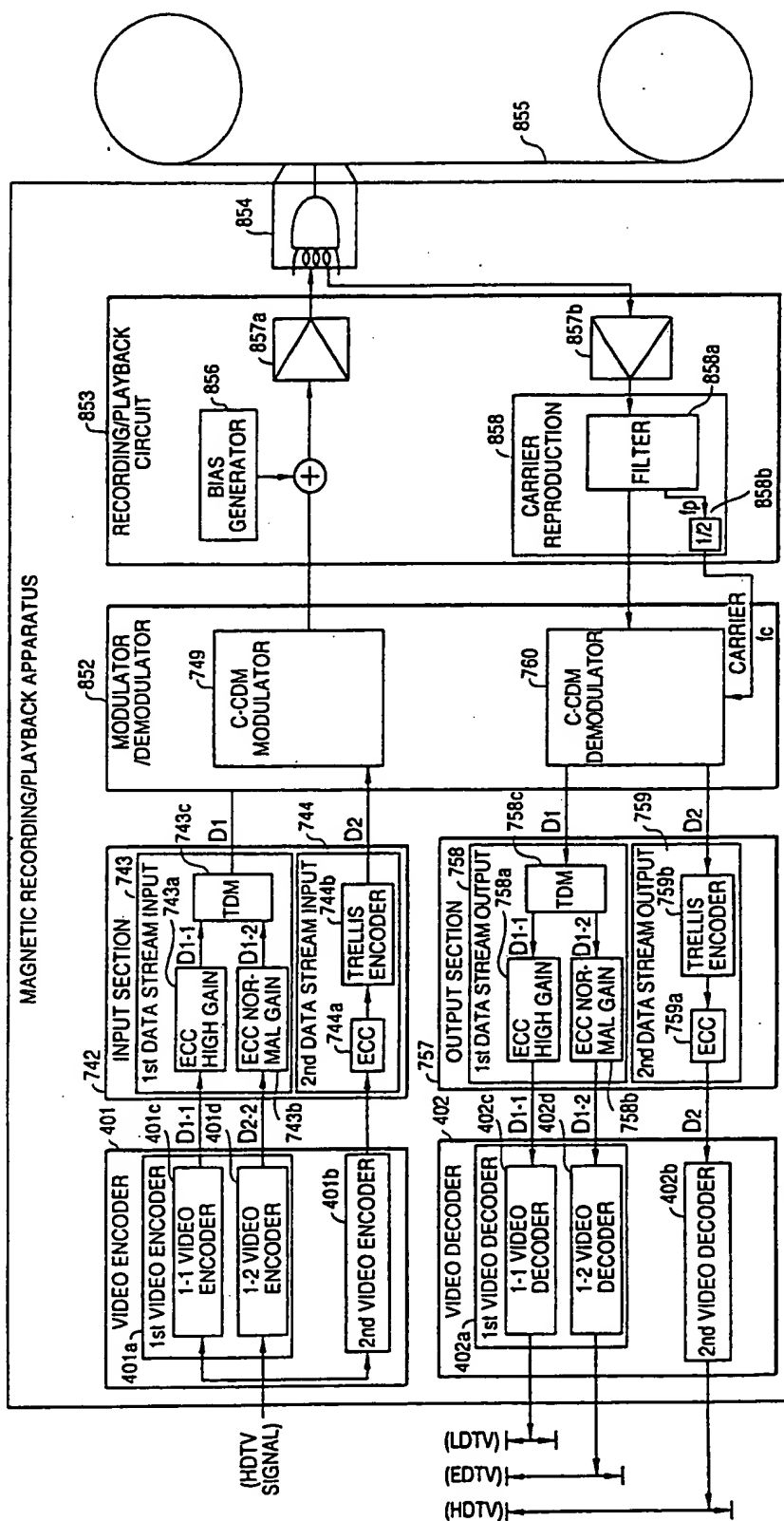


FIG. 132

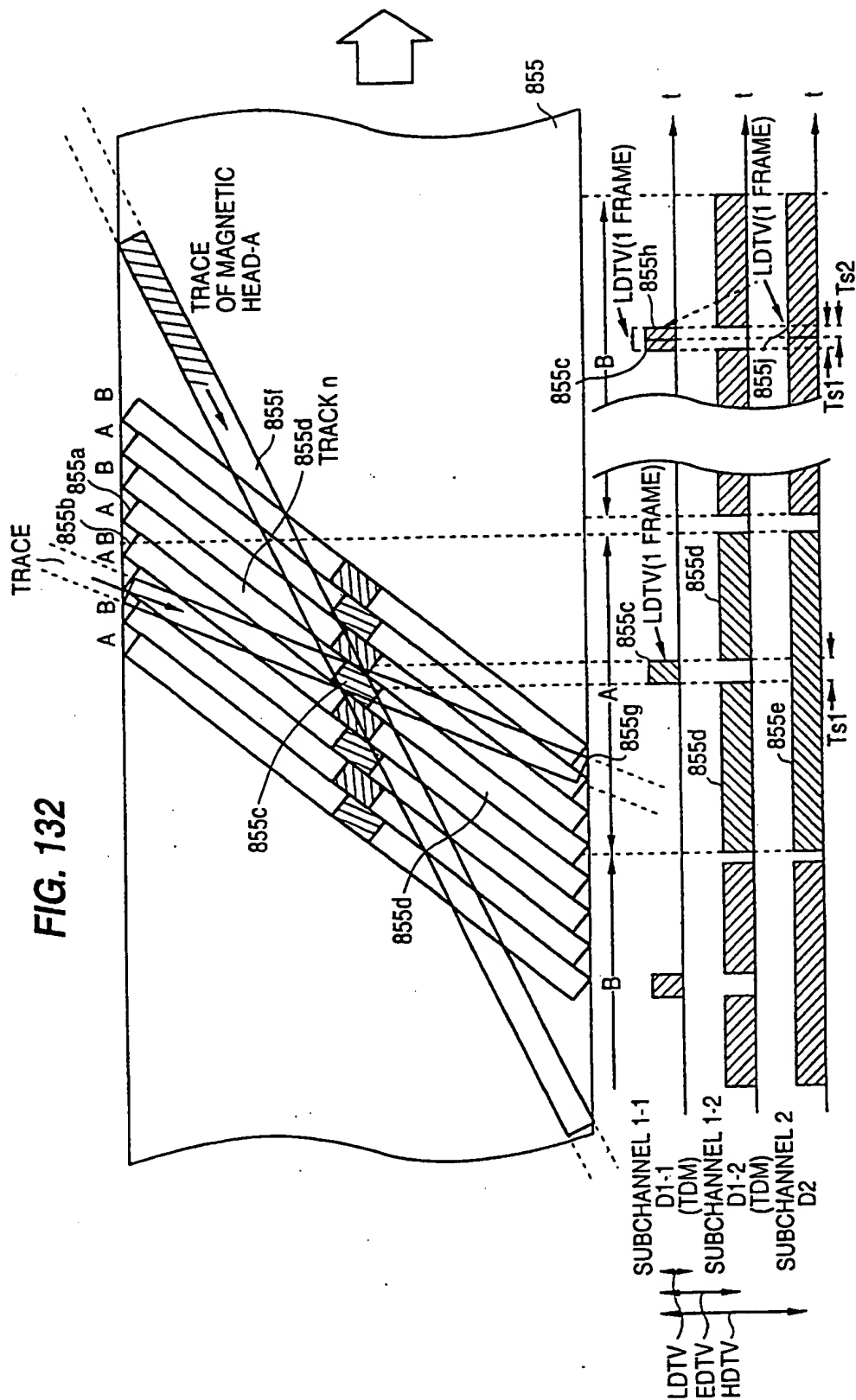


FIG. 133

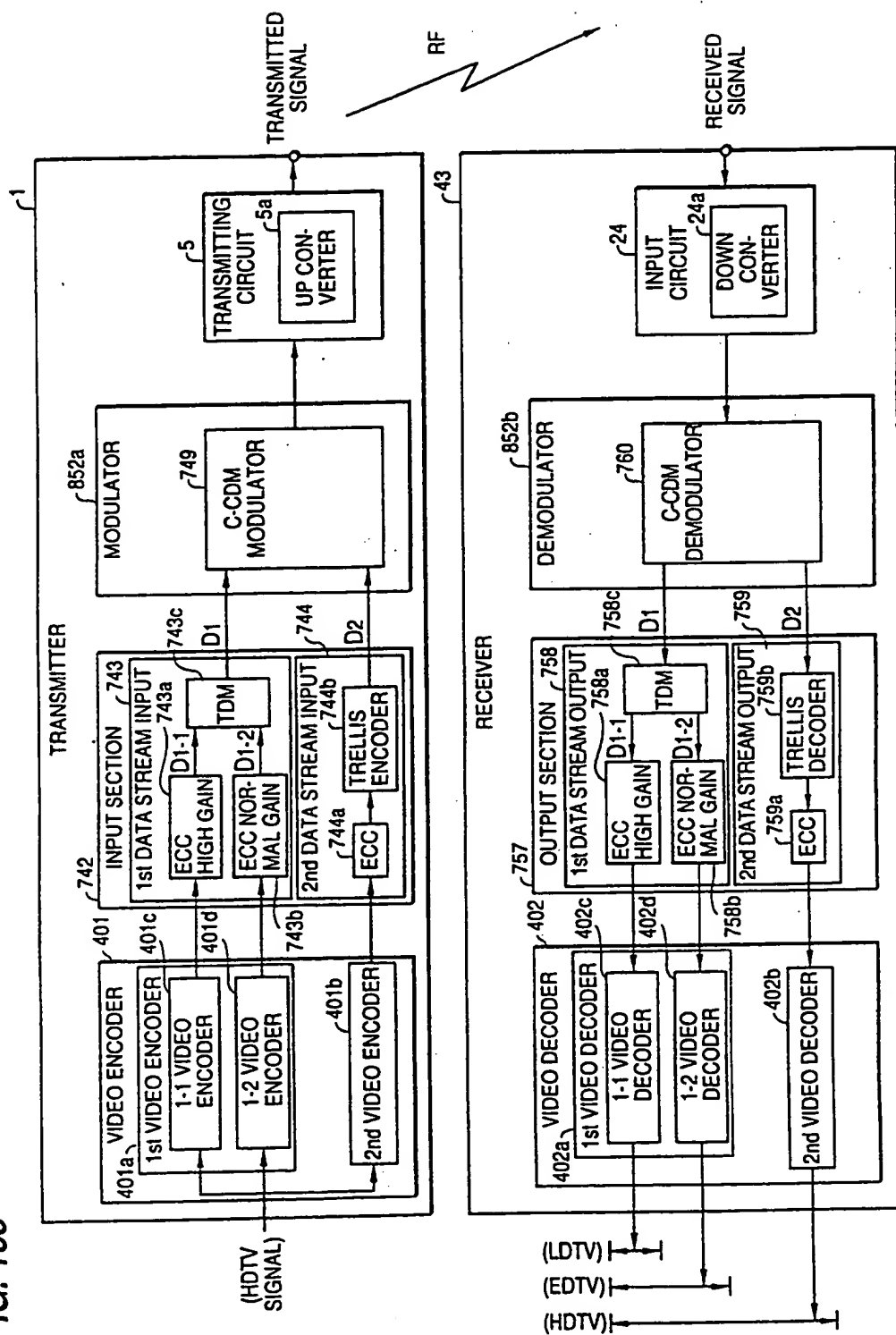


FIG. 134

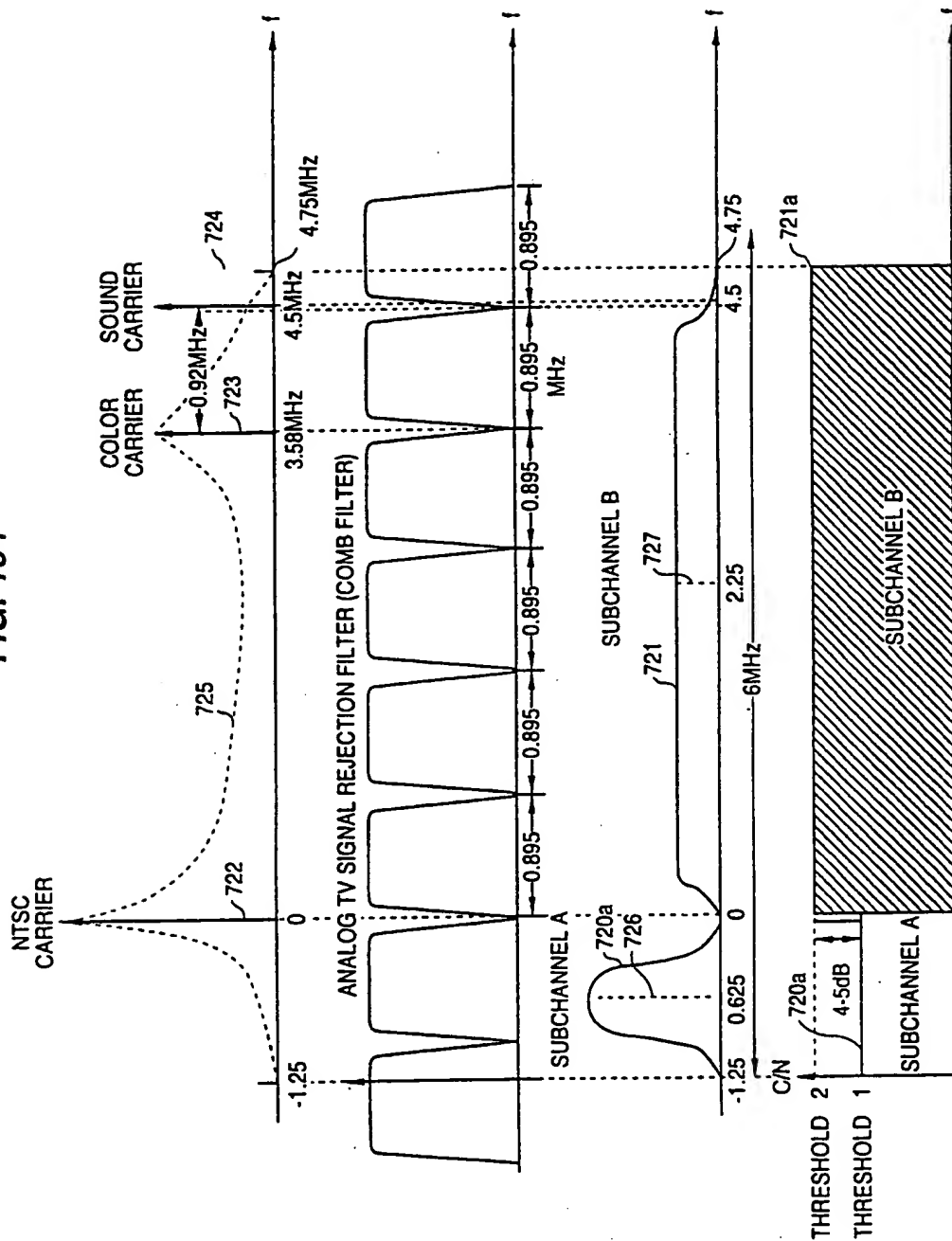


FIG. 135

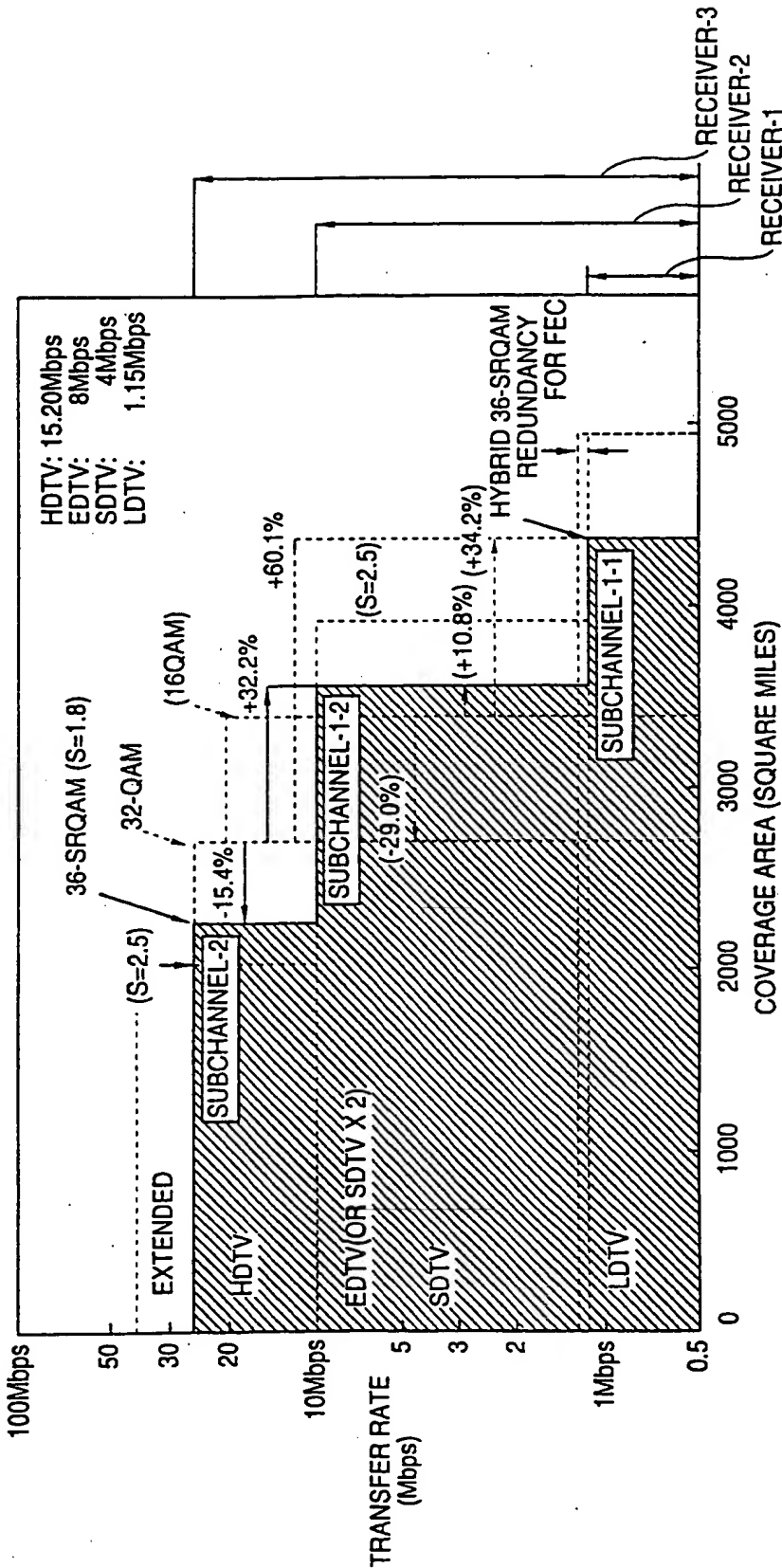


FIG. 136

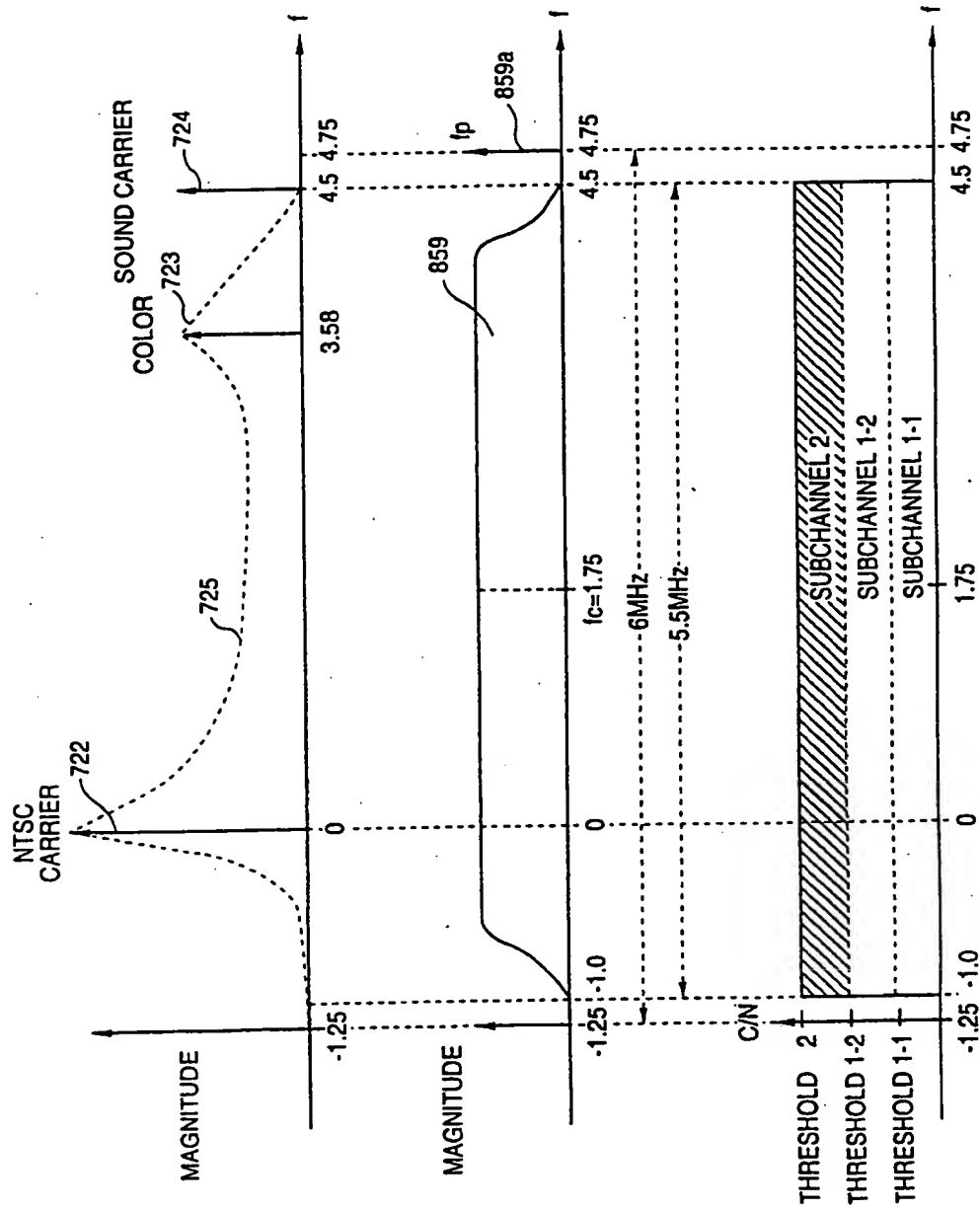


FIG. 137

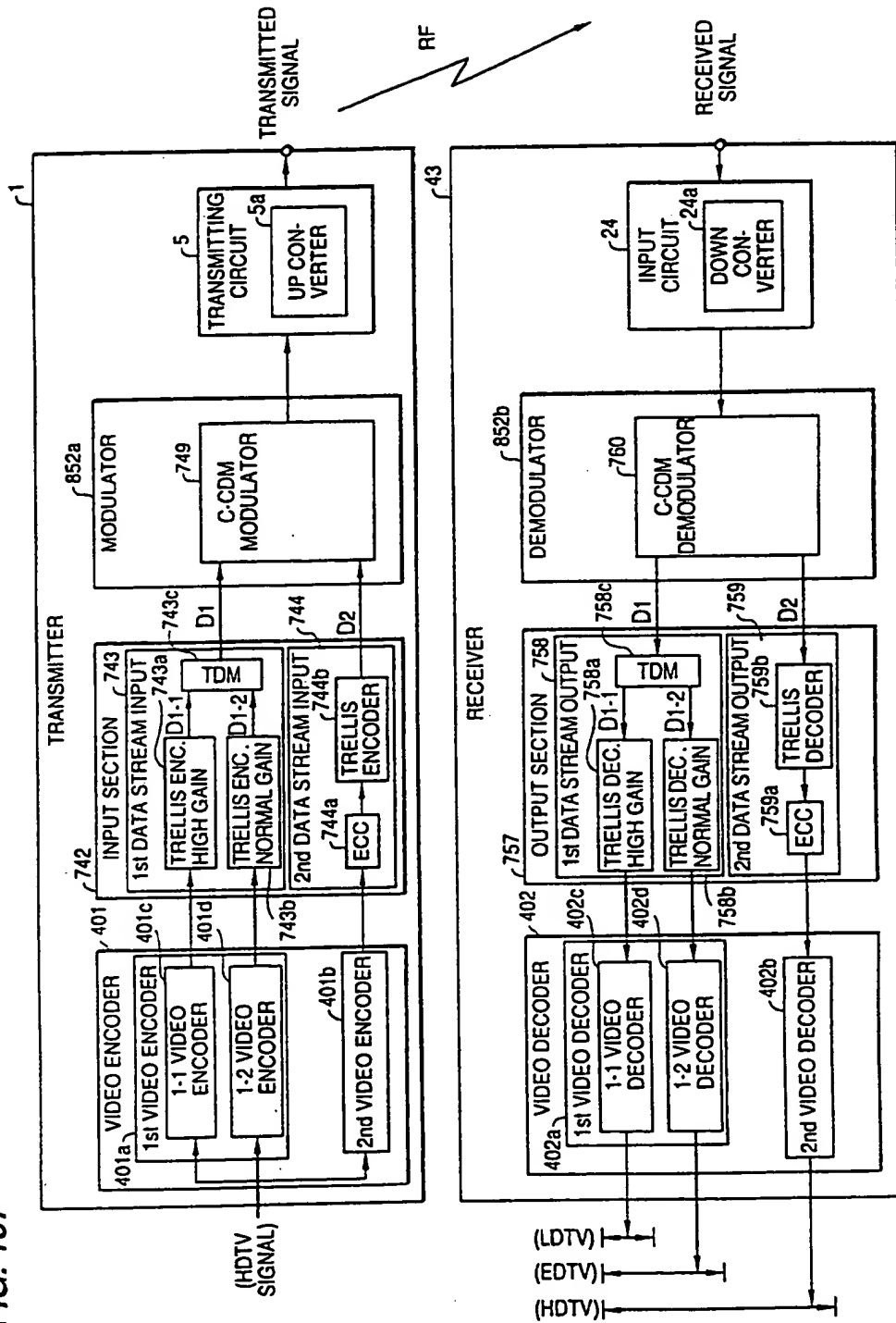


FIG. 138

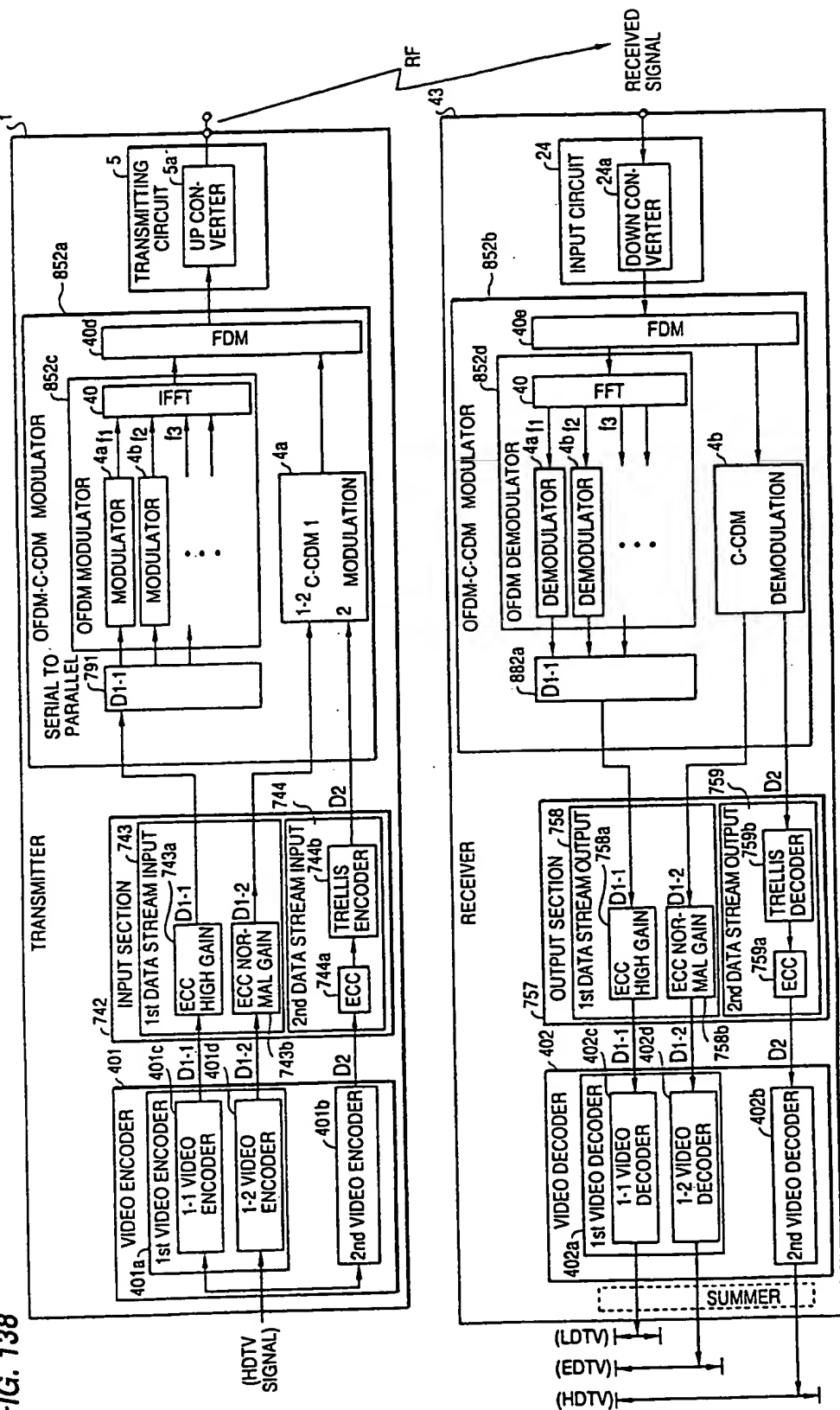


FIG. 139

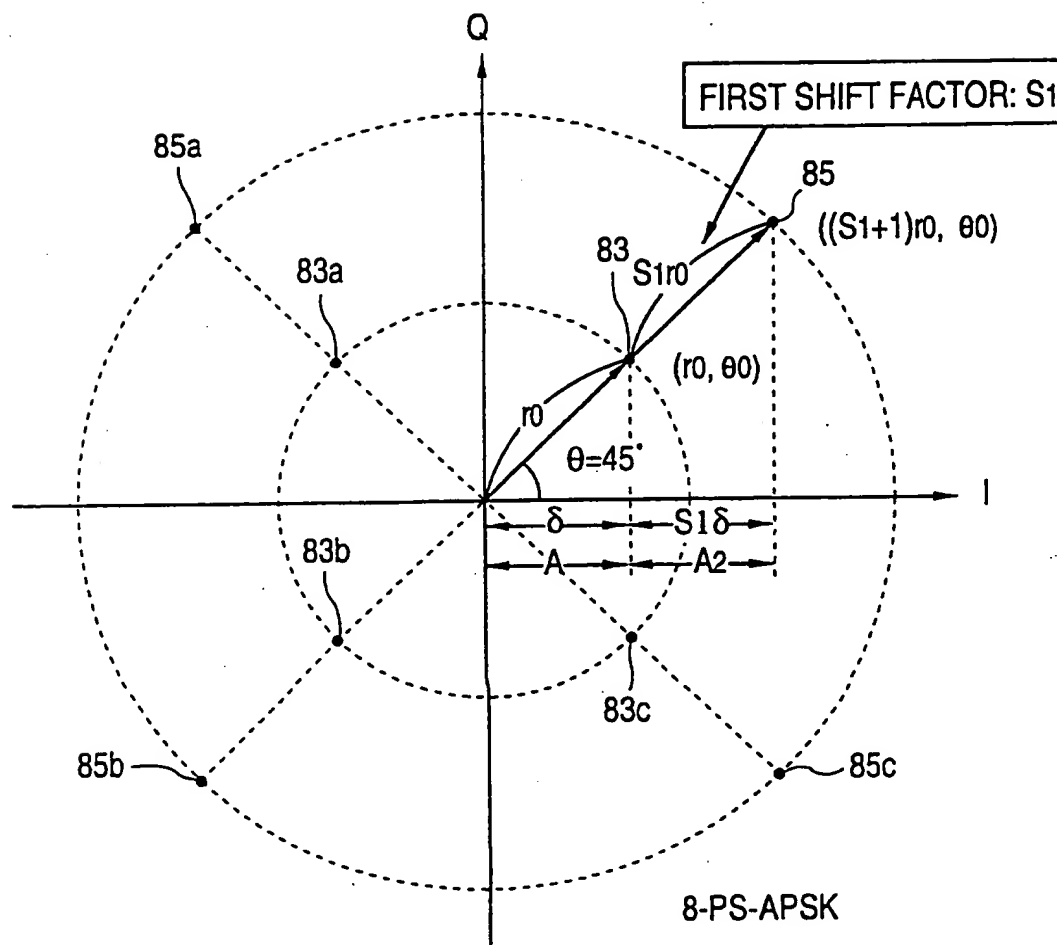


FIG. 140

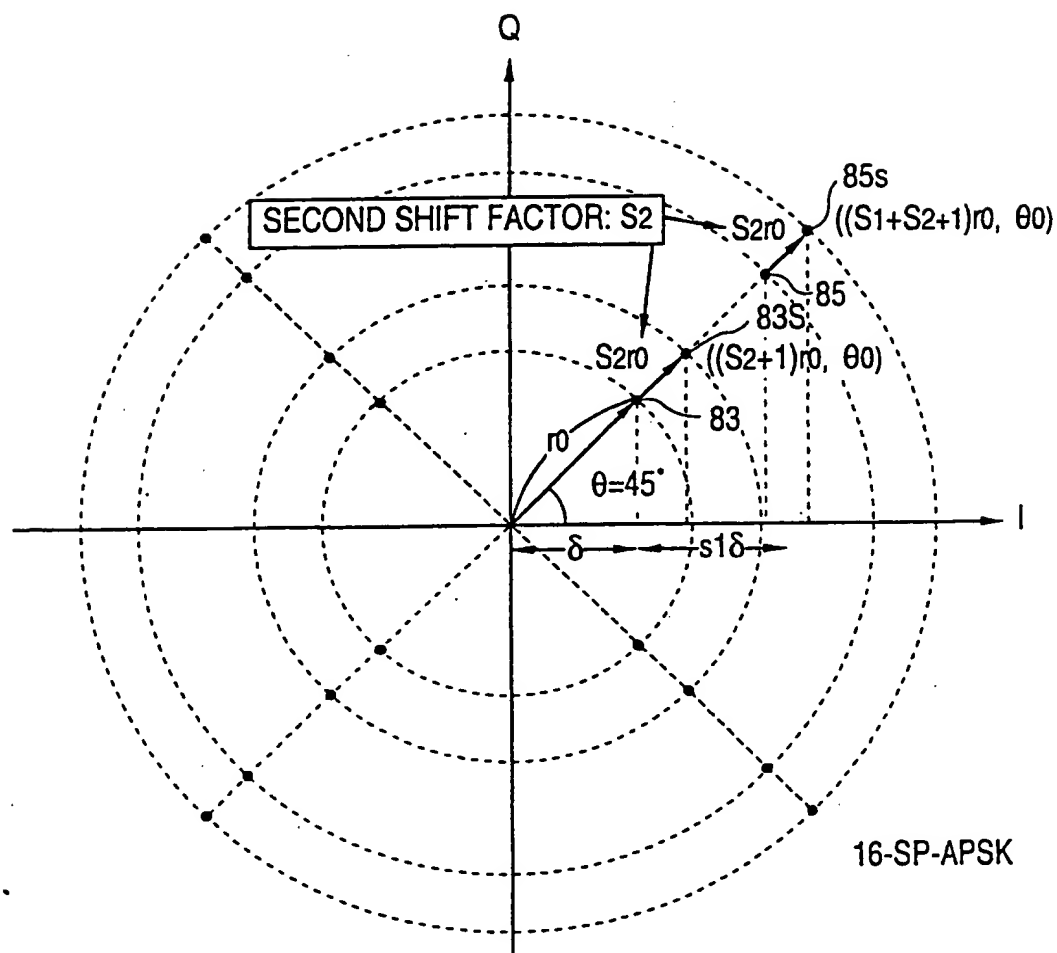


FIG. 141

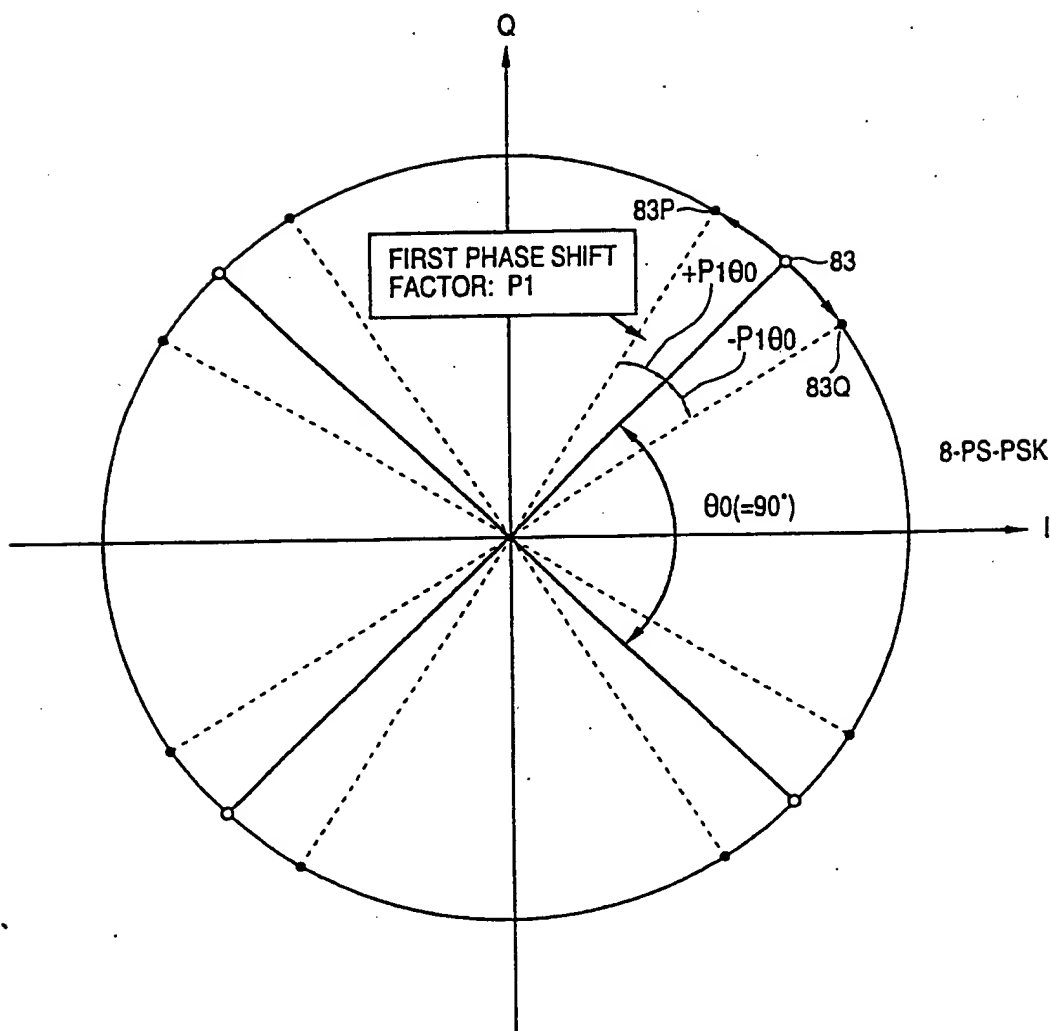
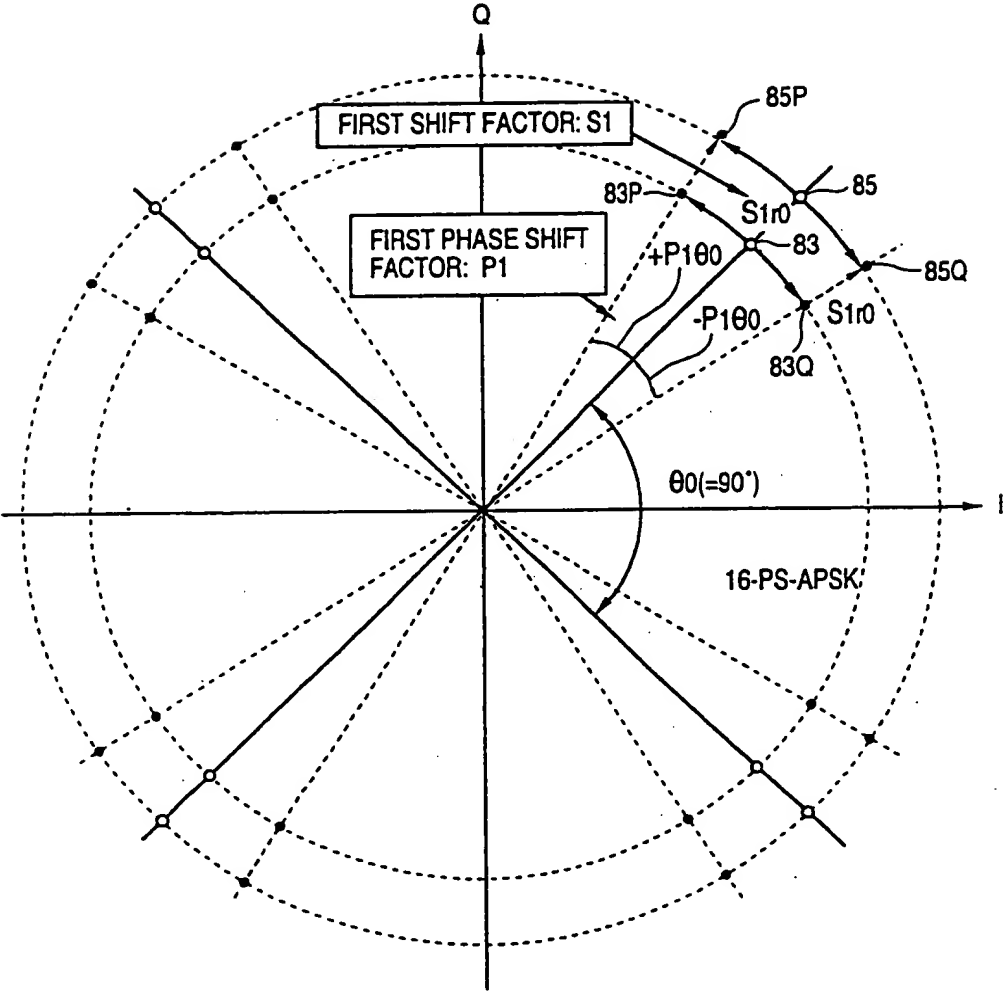


FIG. 142



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FIG. 143

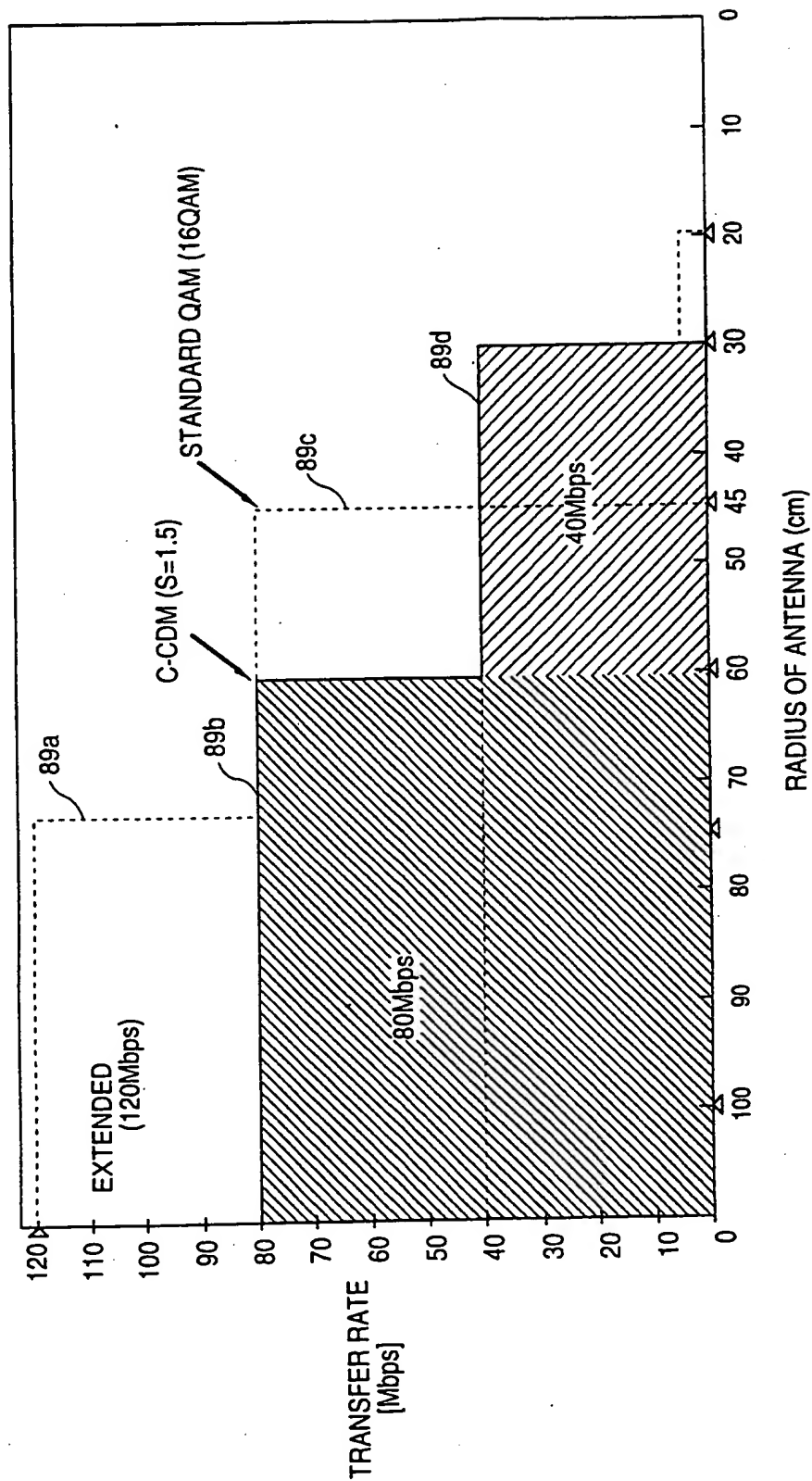


FIG. 144

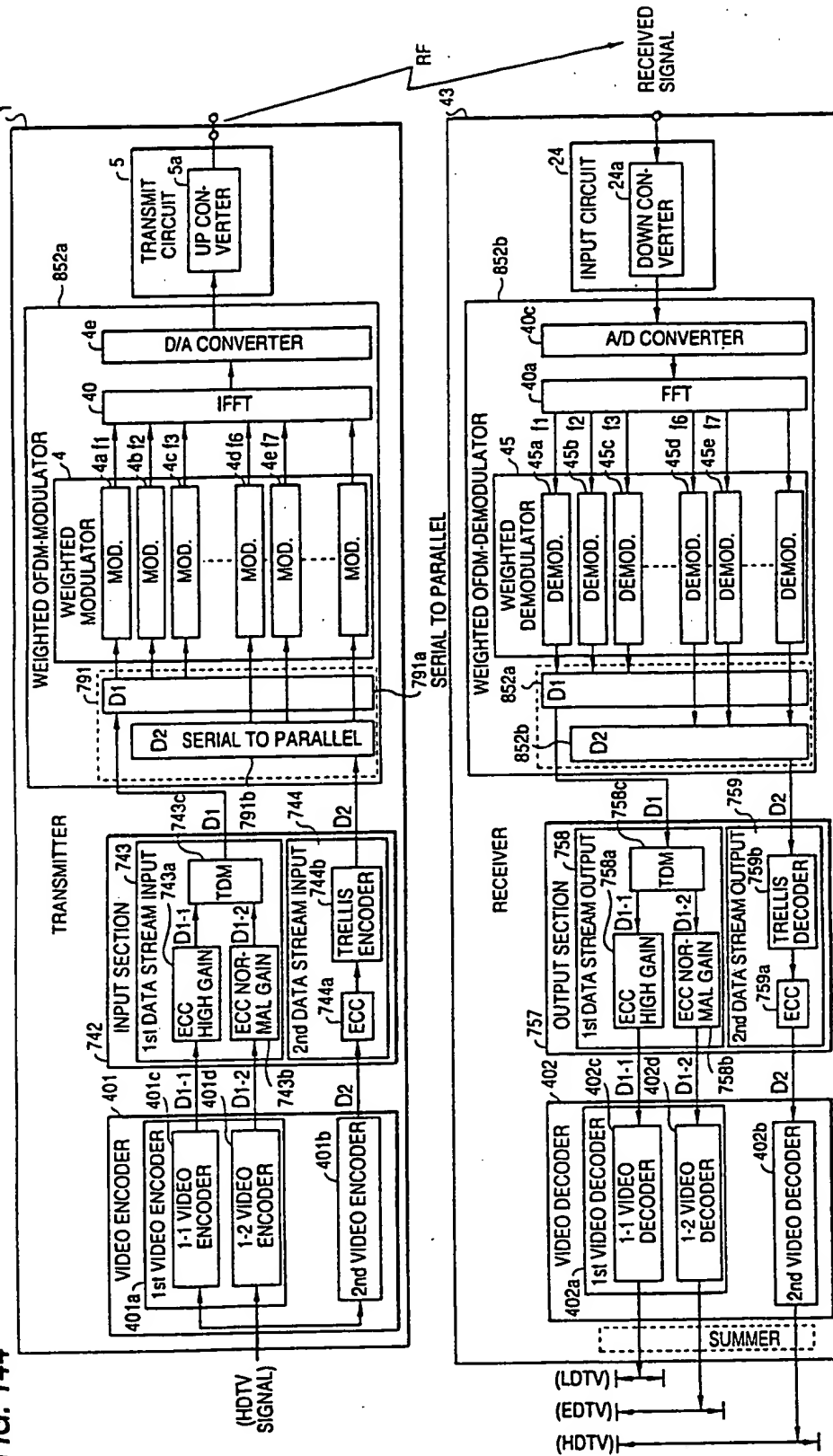


FIG. 145(a)

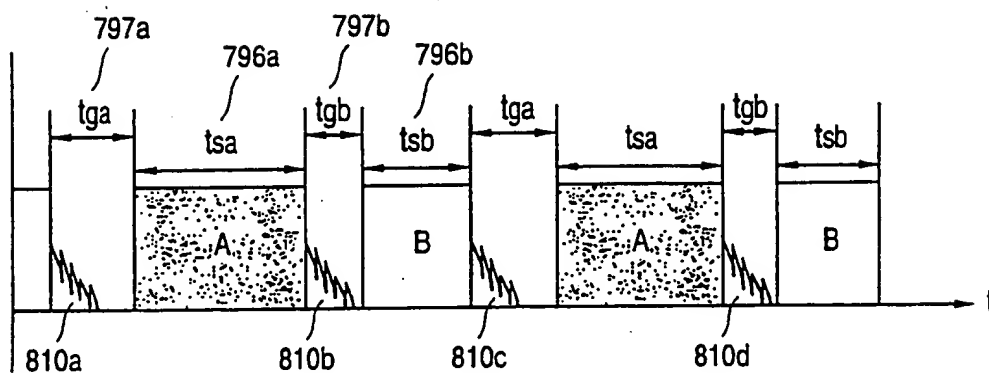
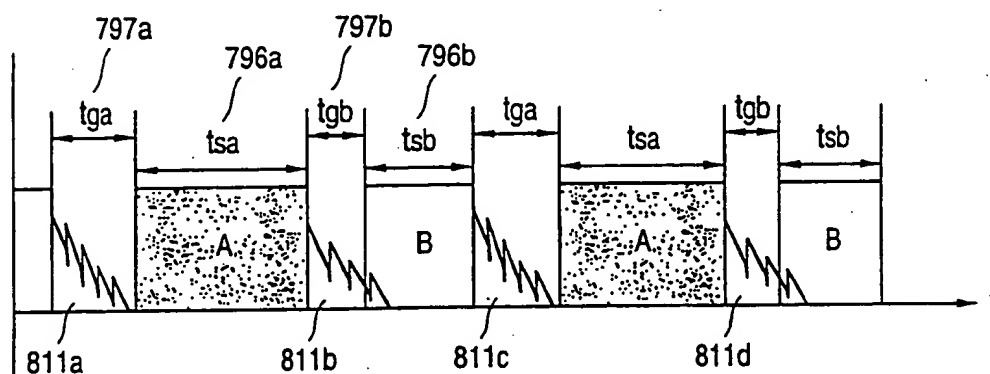


FIG. 145(b)



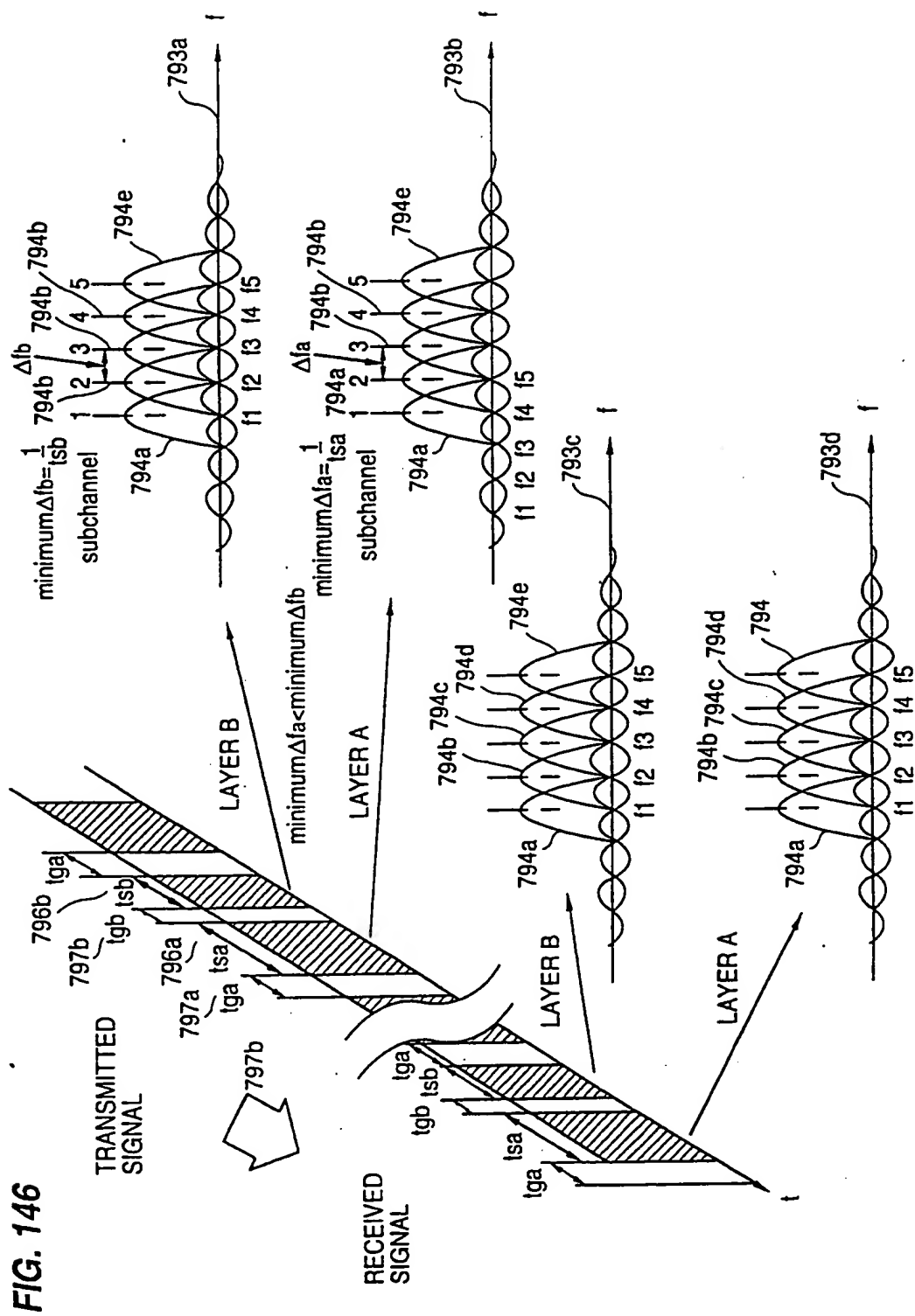


FIG. 147

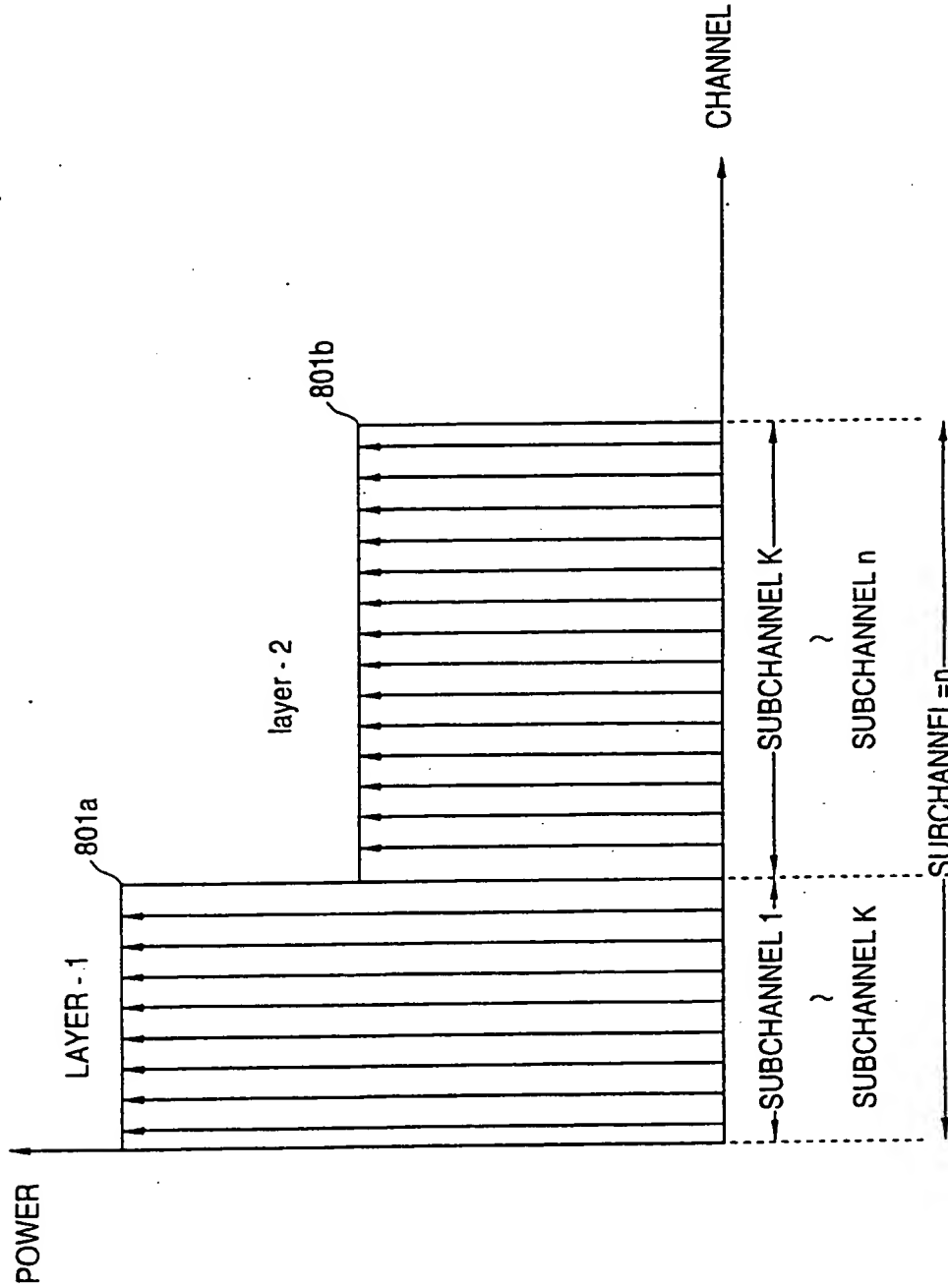
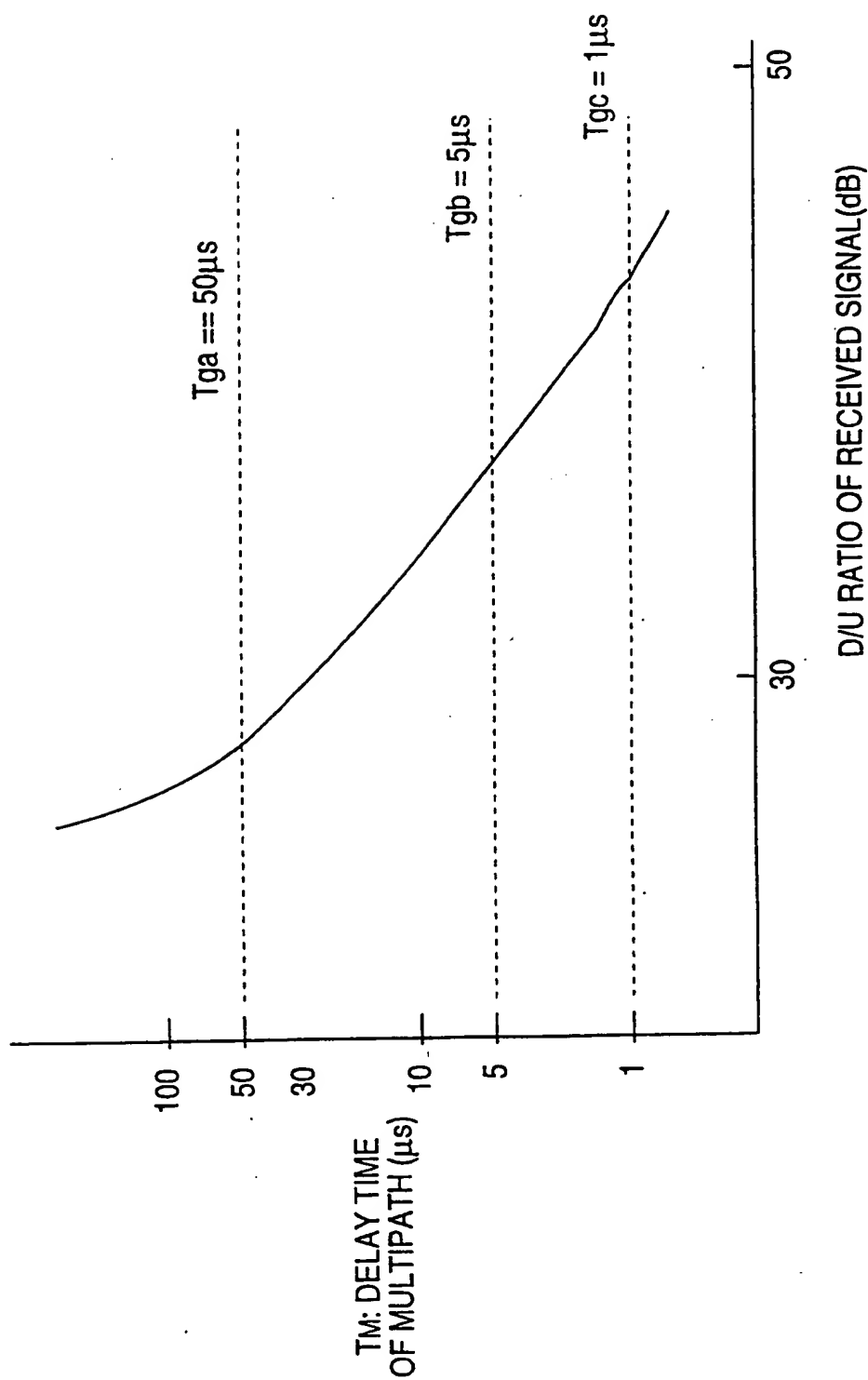


FIG. 148



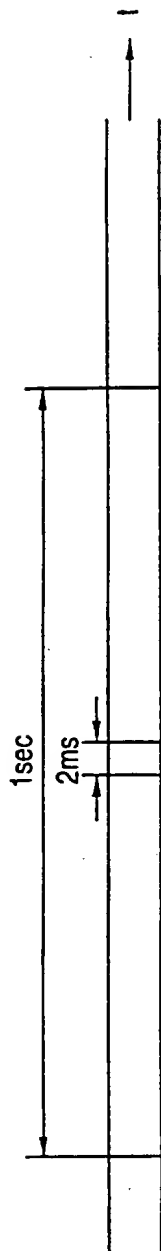


FIG. 149(b)

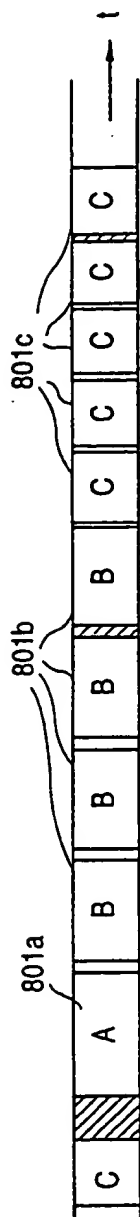


FIG. 149(c)

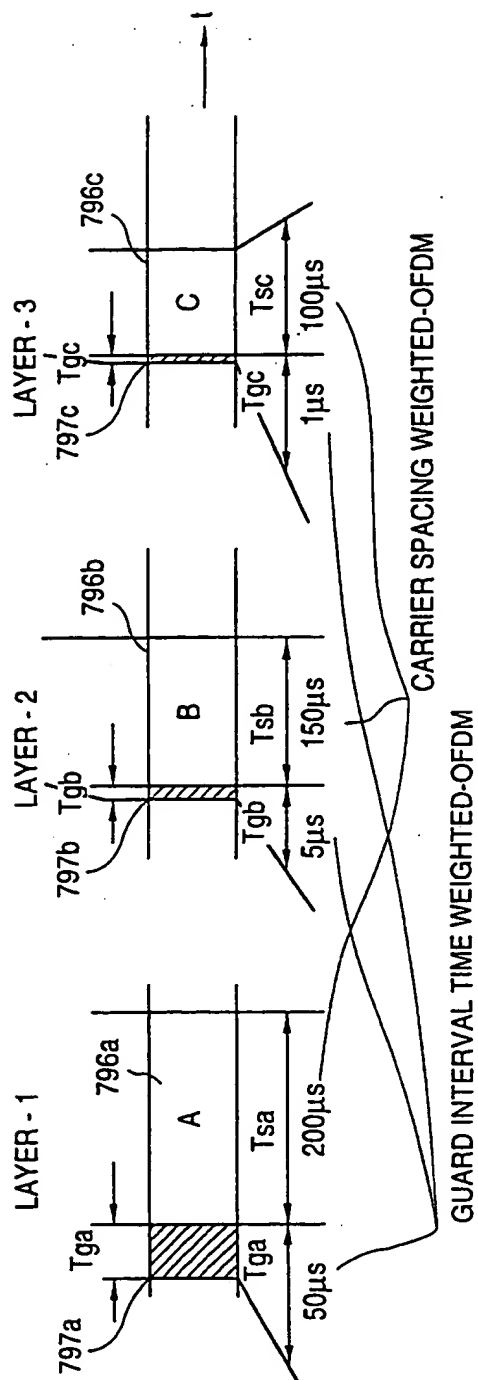


FIG. 150

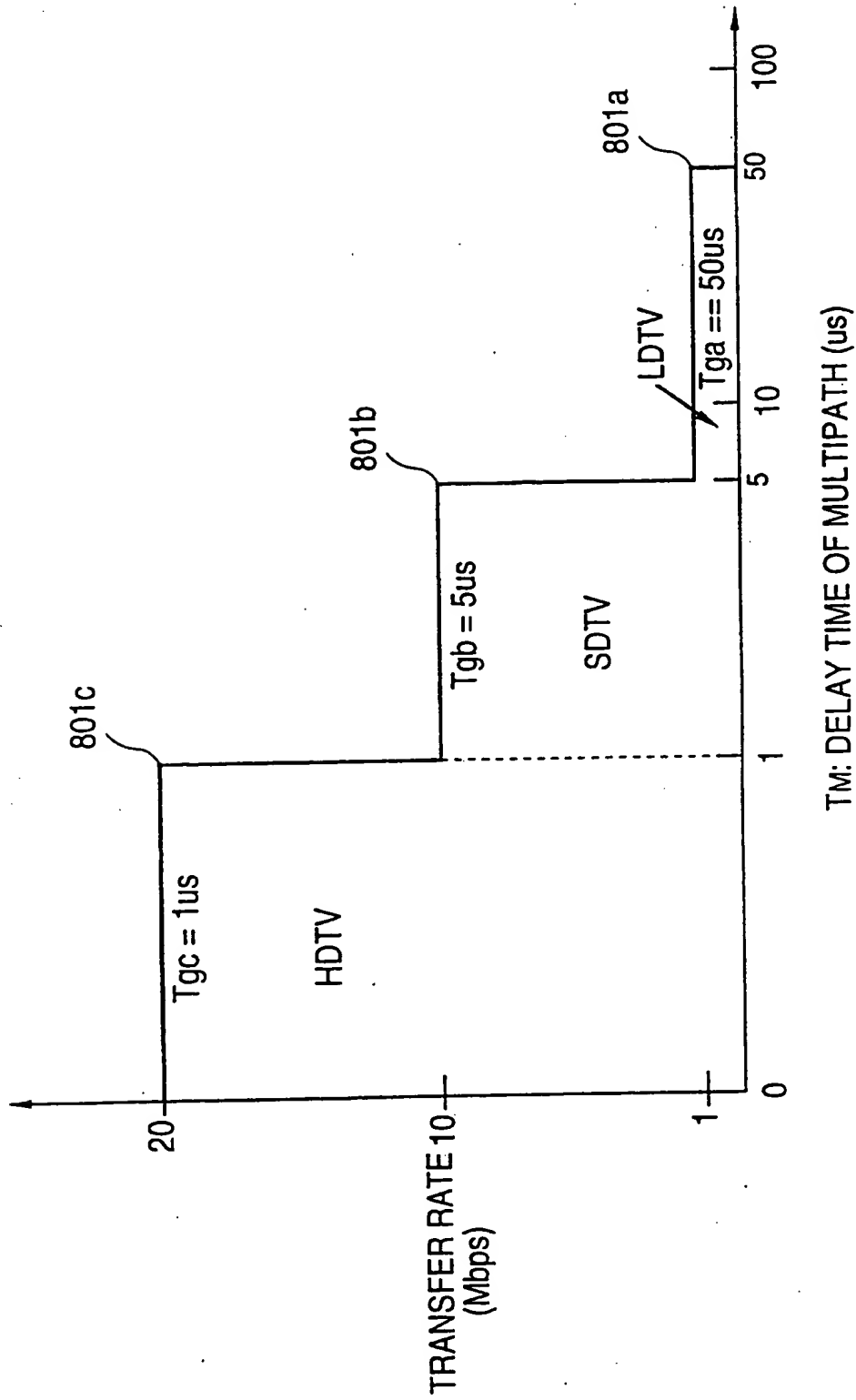


FIG. 151

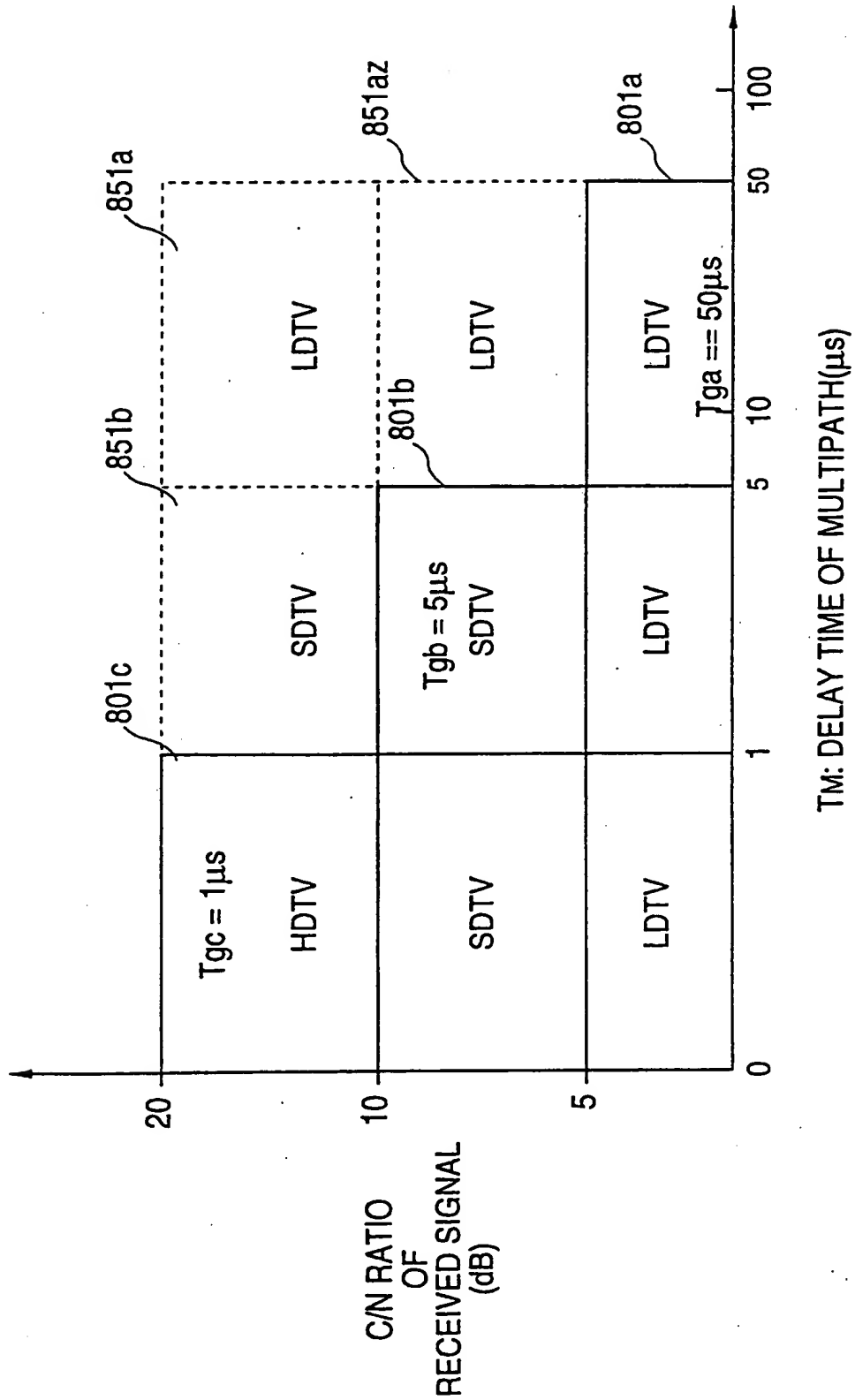


FIG. 152

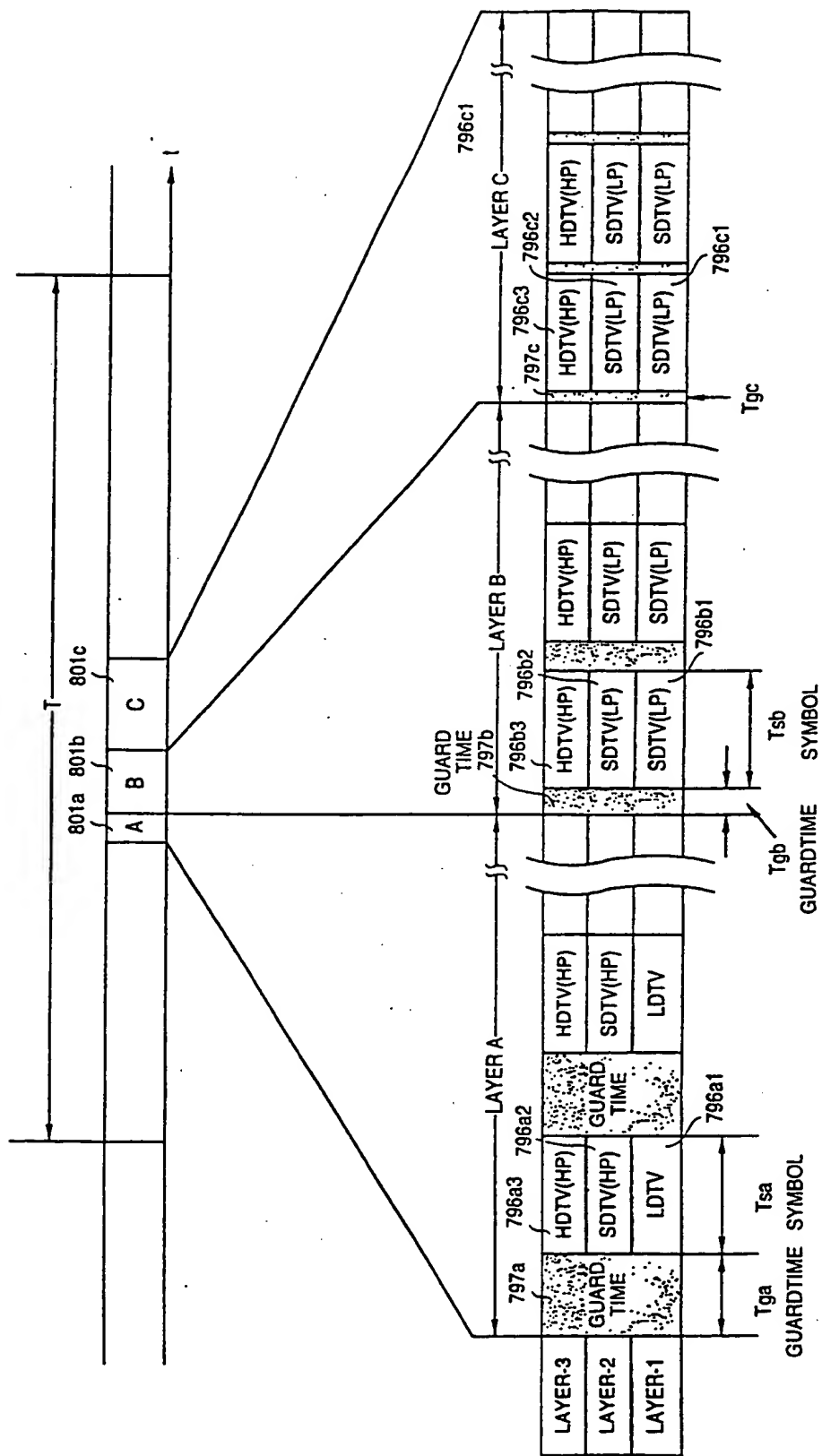
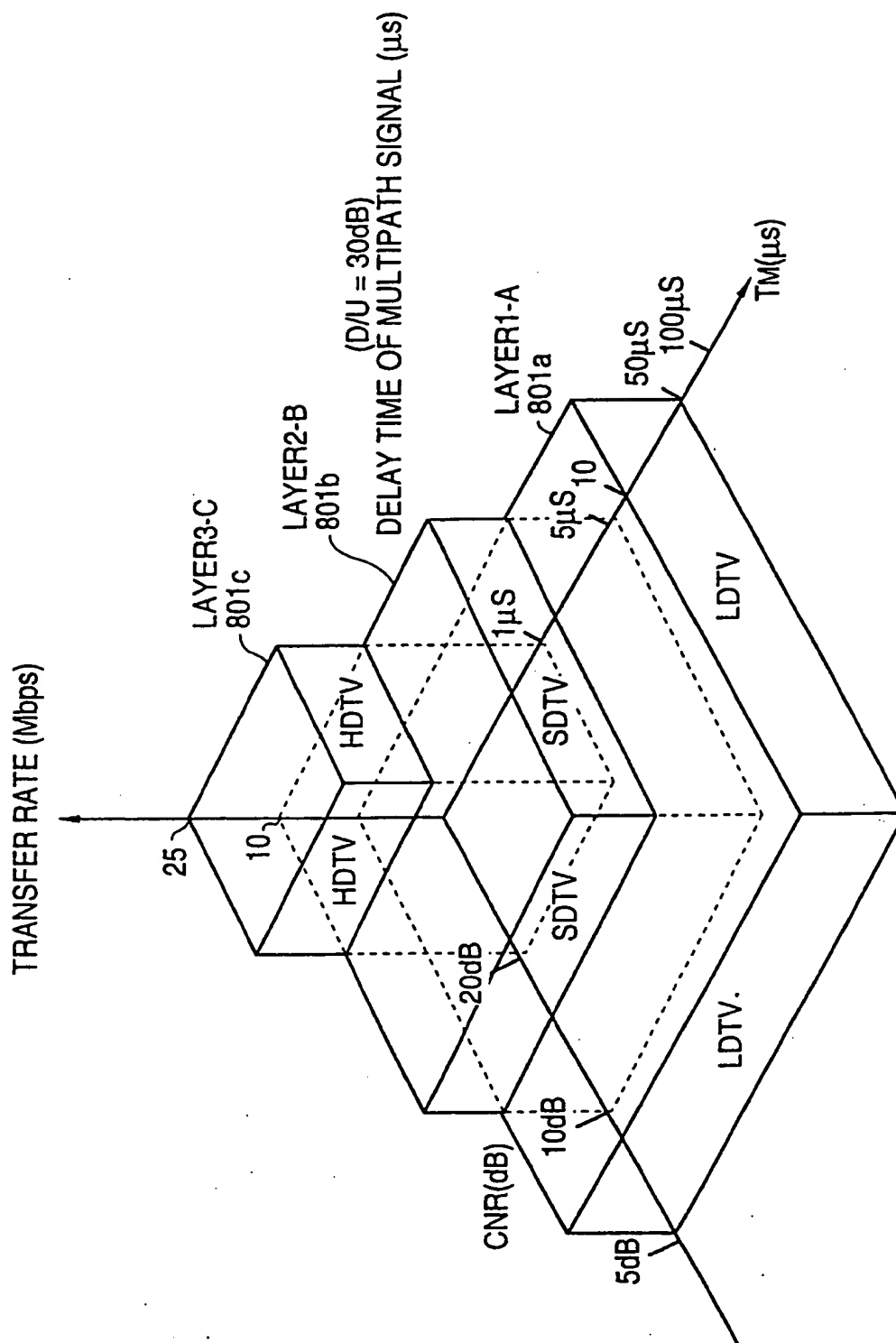
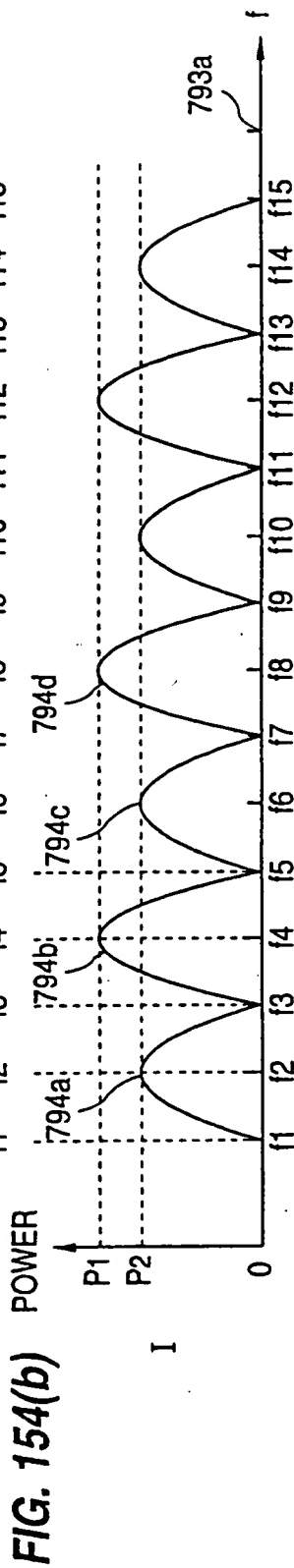
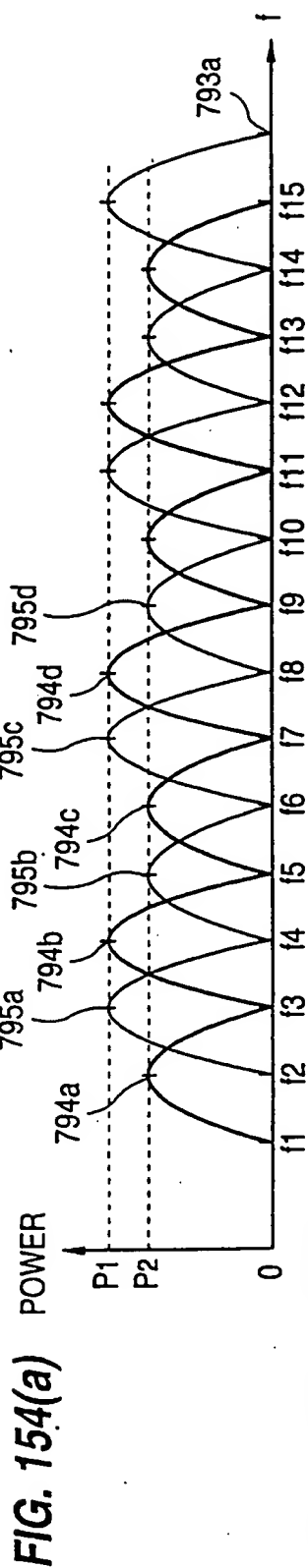
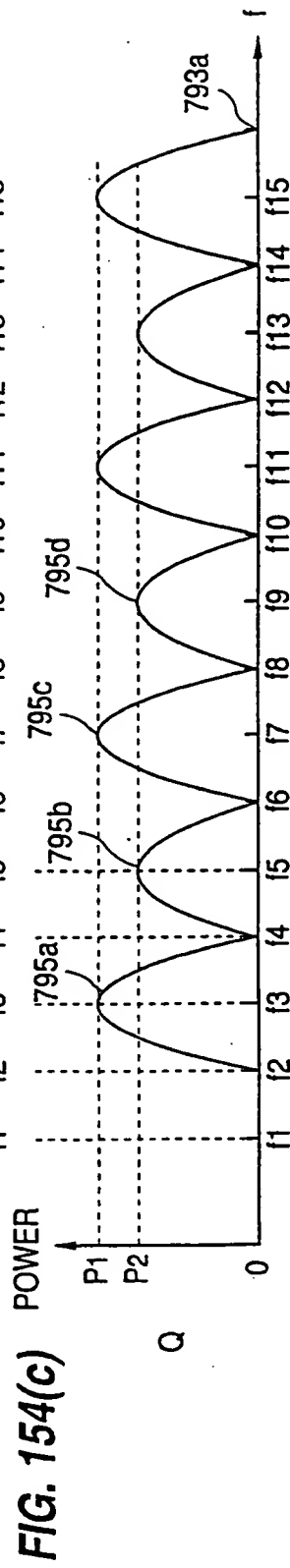


FIG. 153





I



Q

FIG. 155

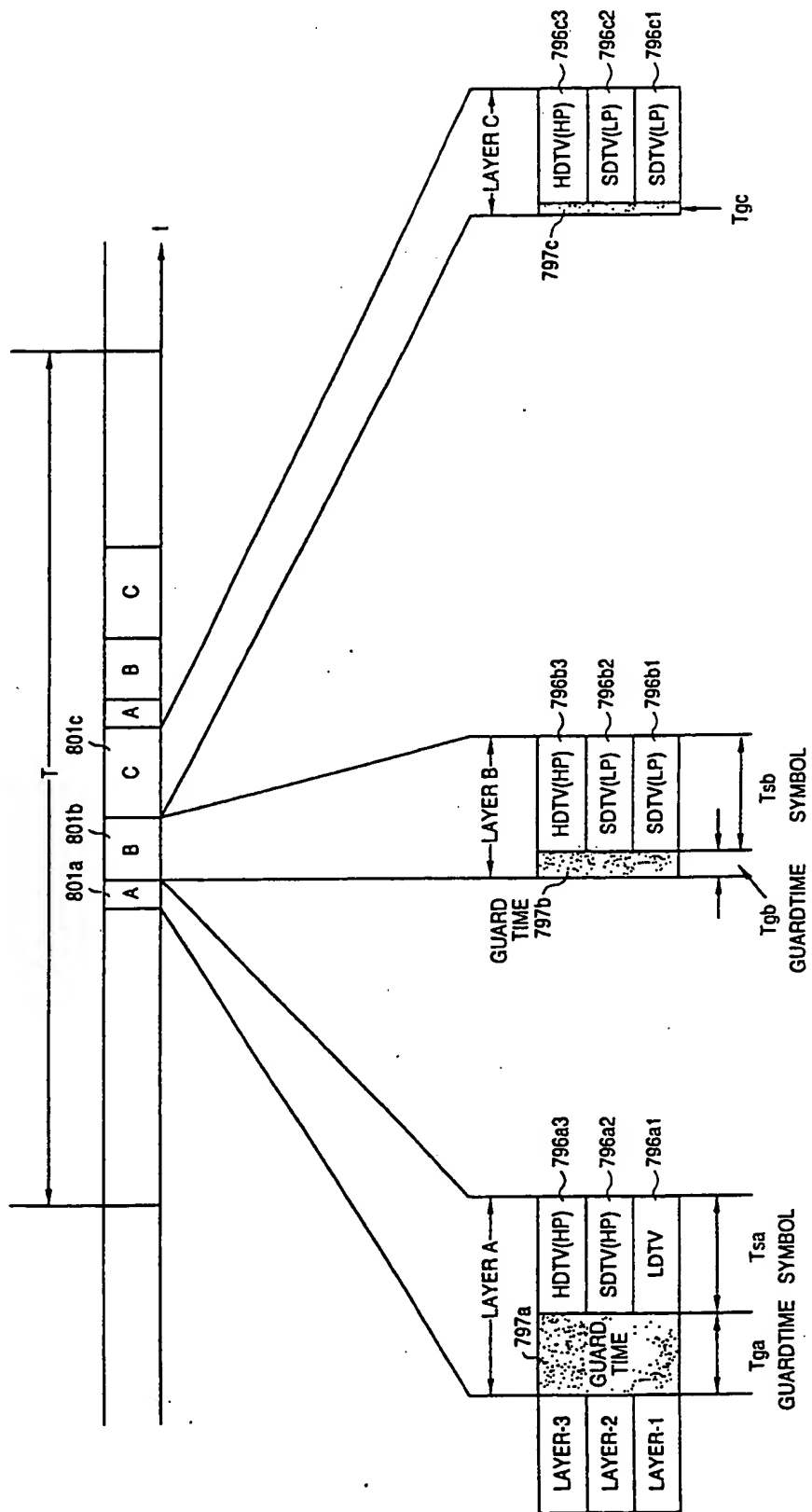


FIG. 156

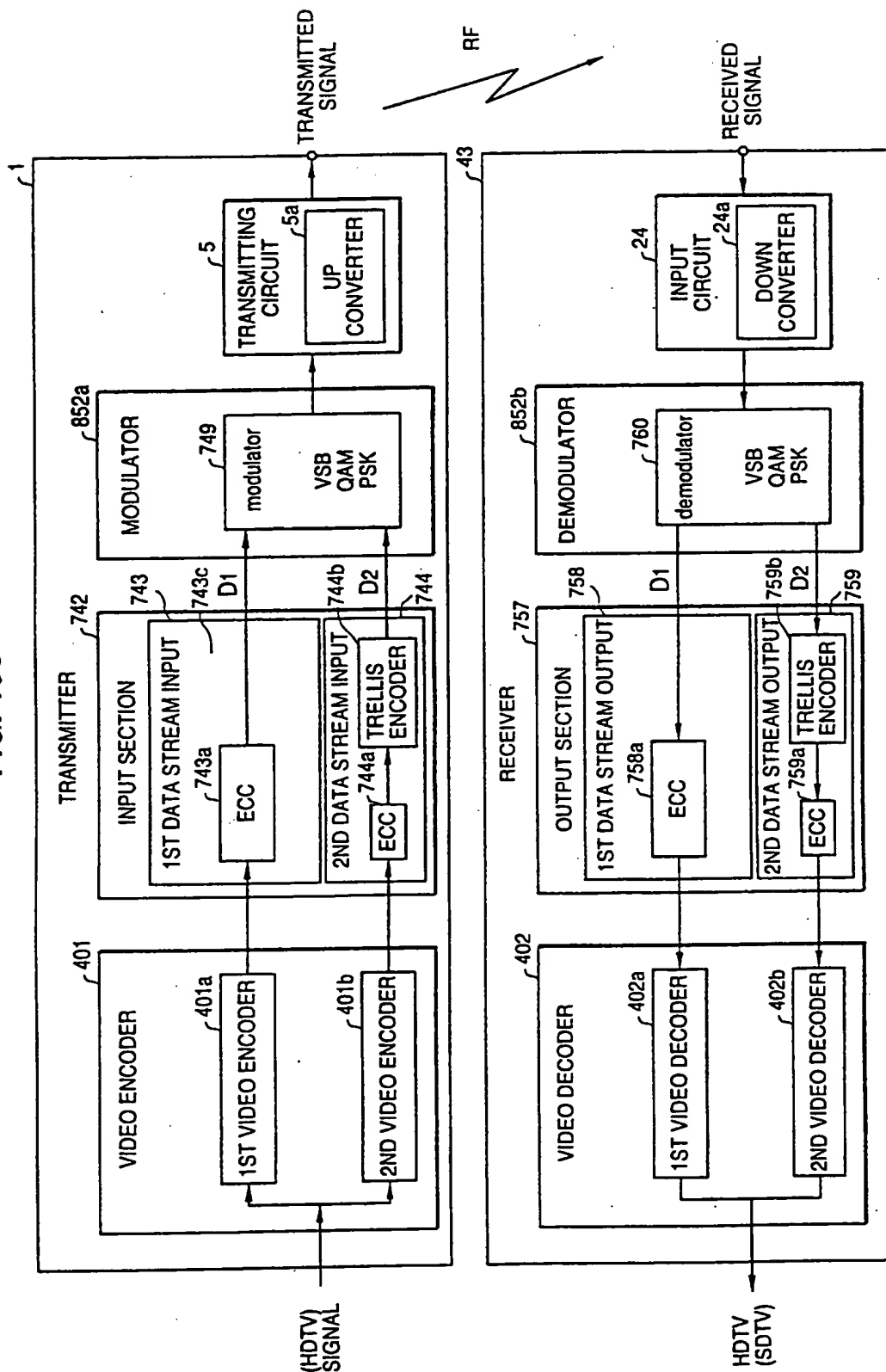


FIG. 157

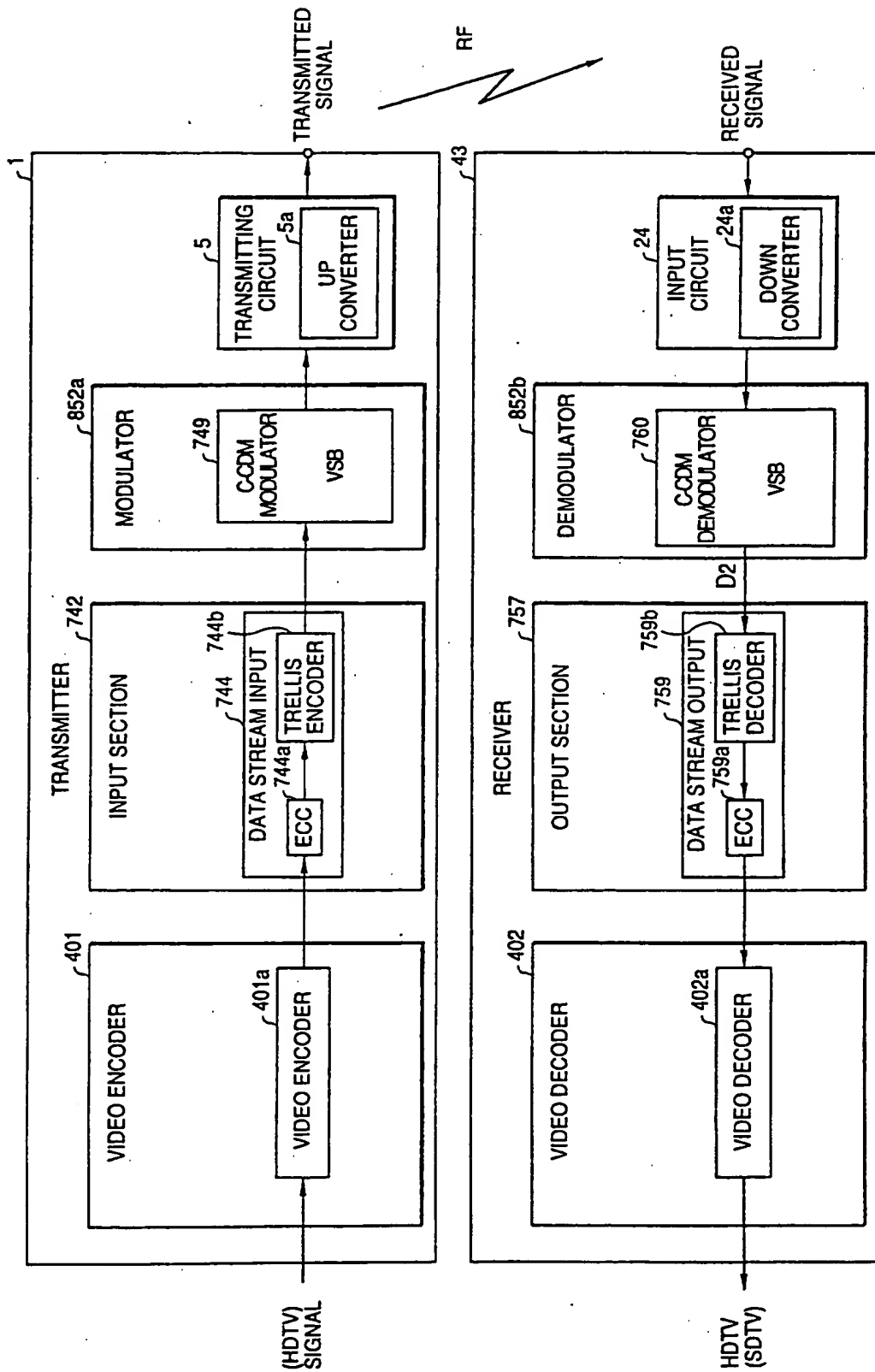
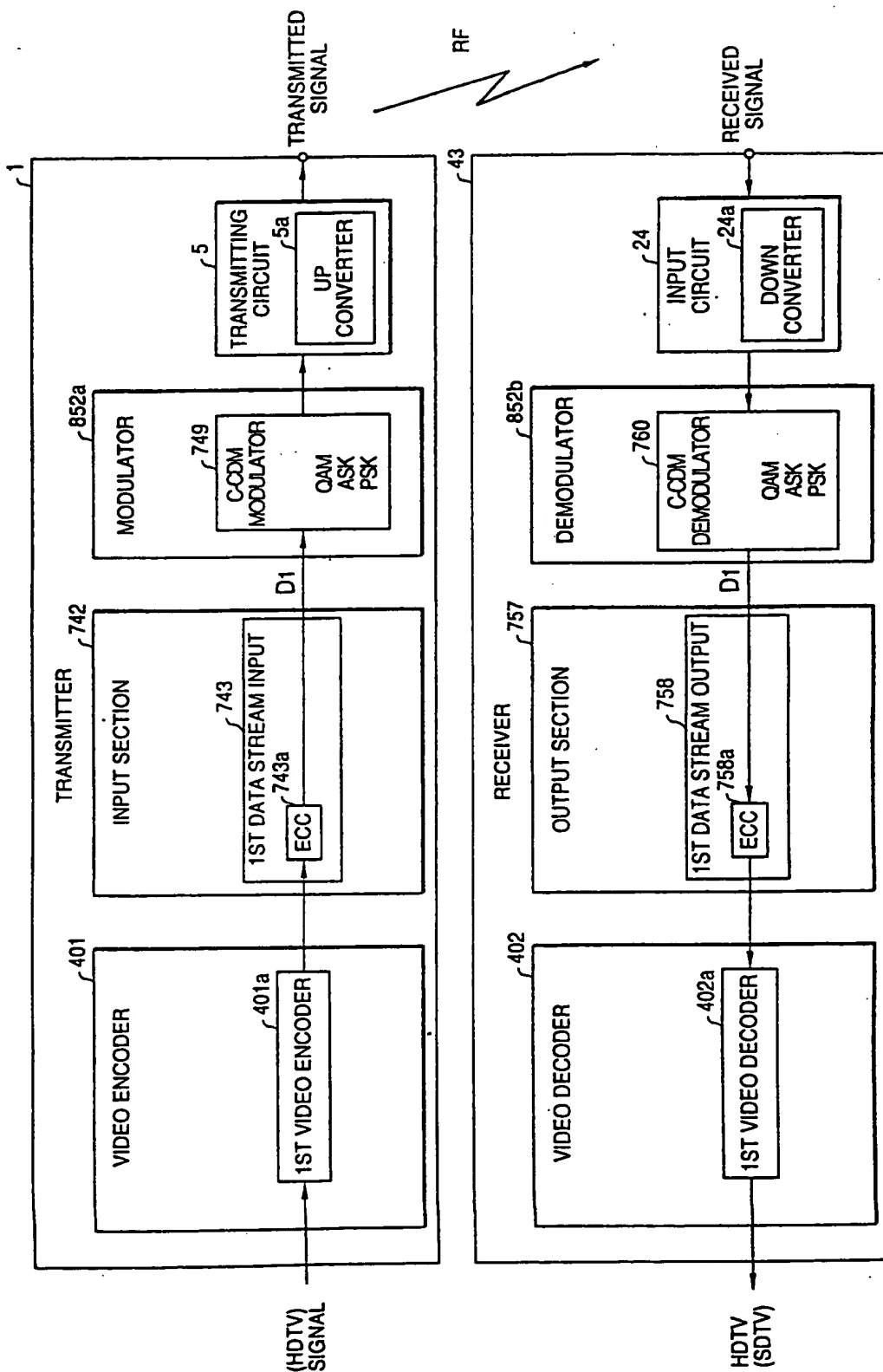
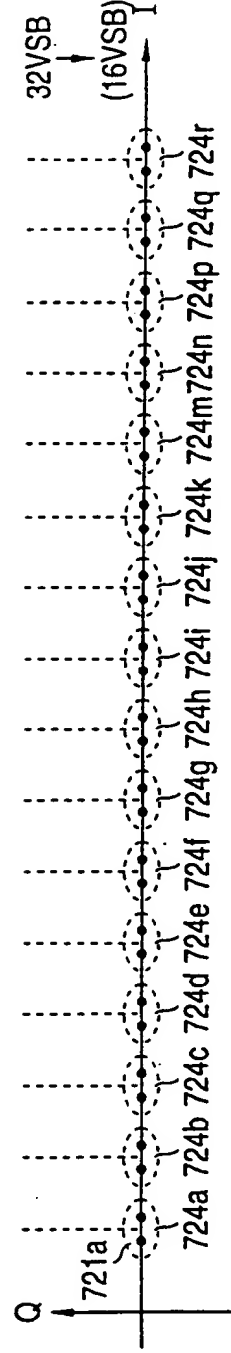
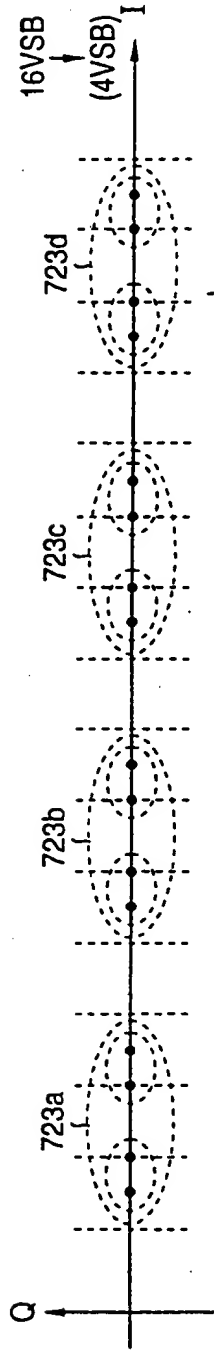
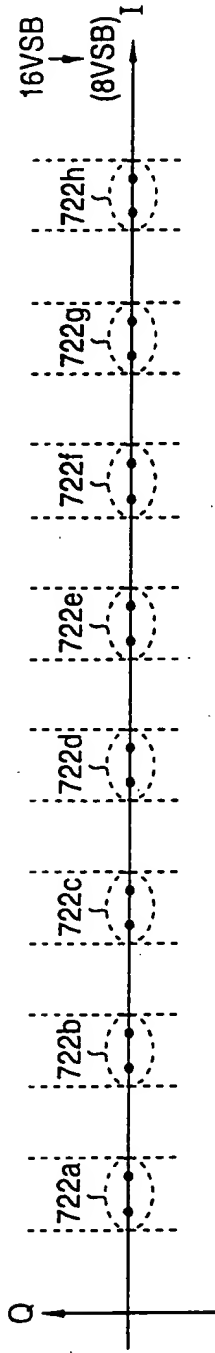
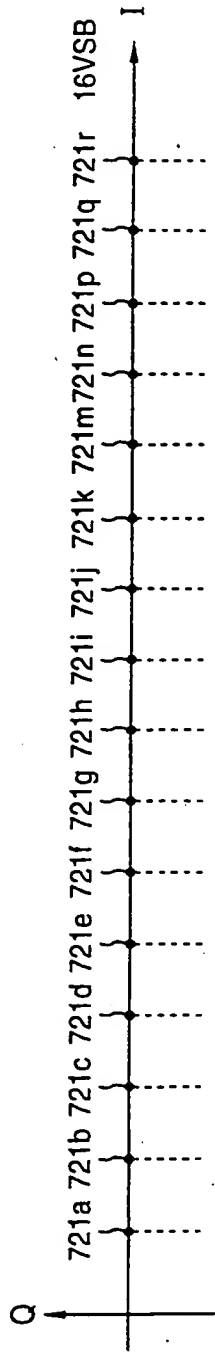


FIG. 158





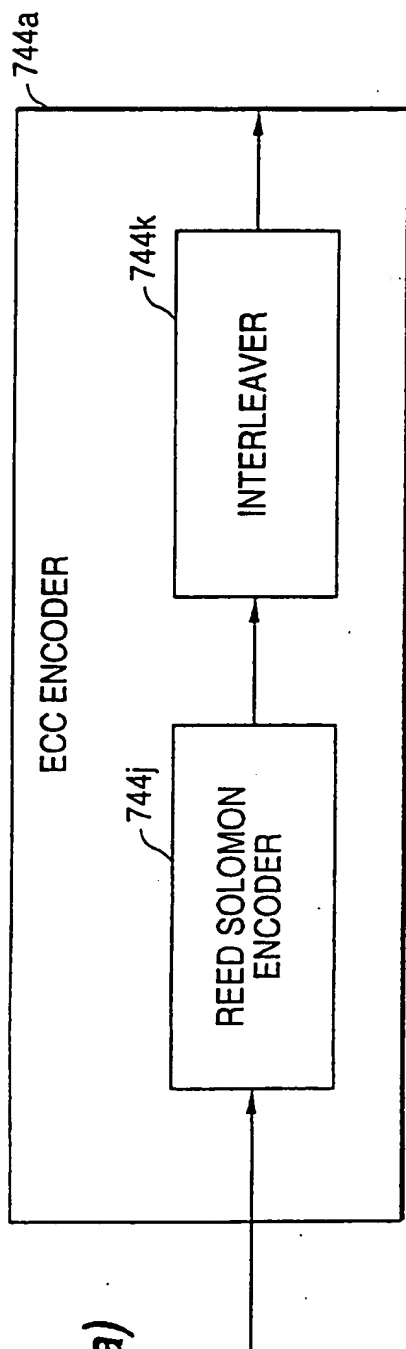


FIG. 160(a)

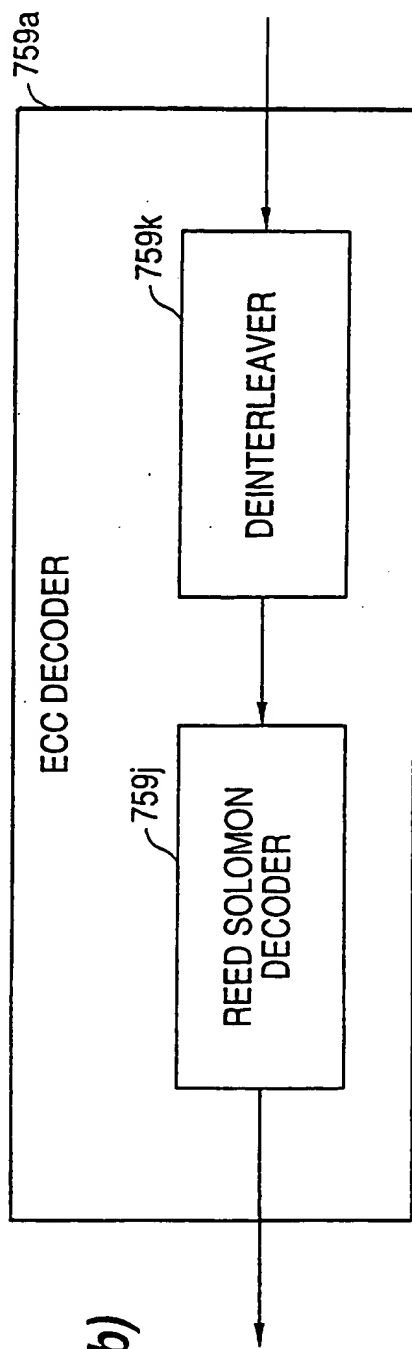


FIG. 160(b)

FIG. 161

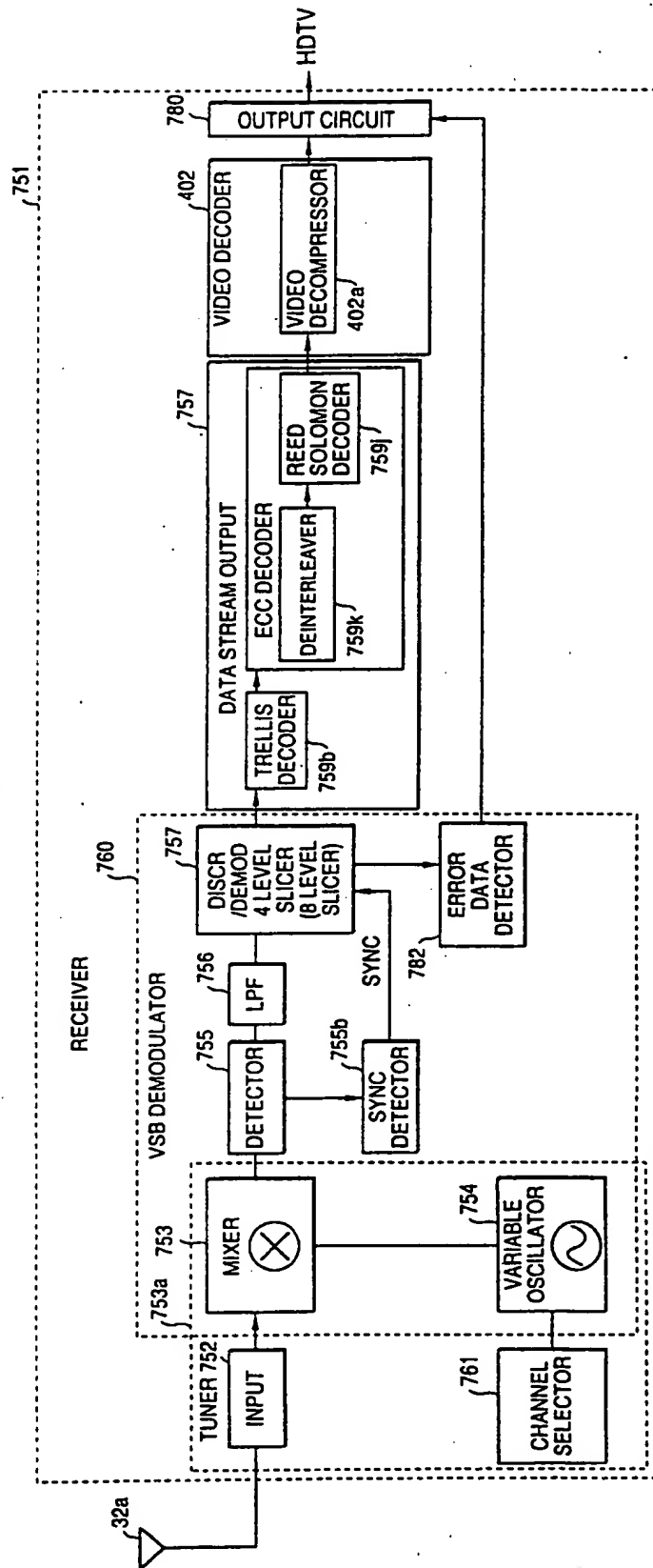


FIG. 162

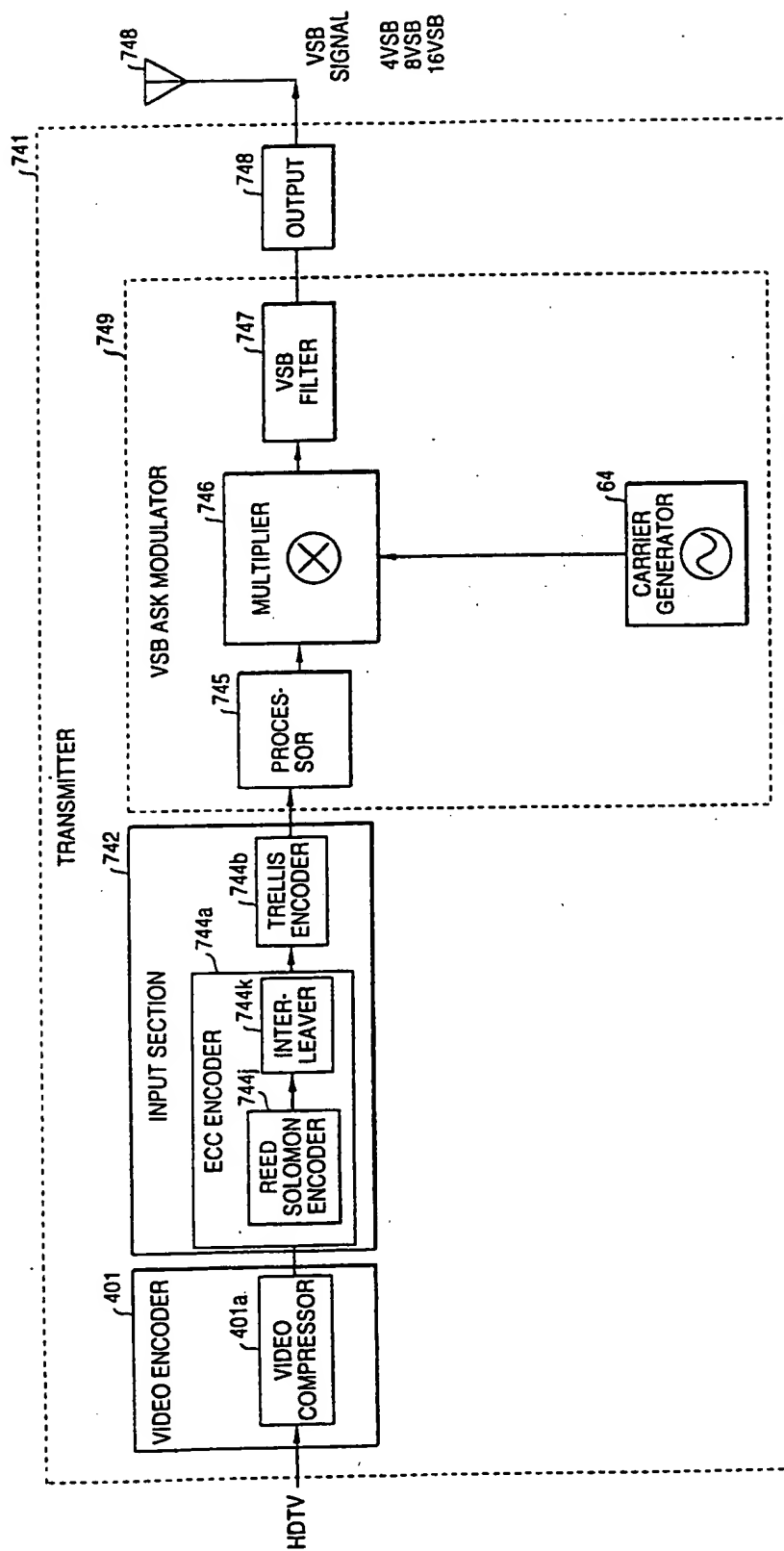


FIG. 163

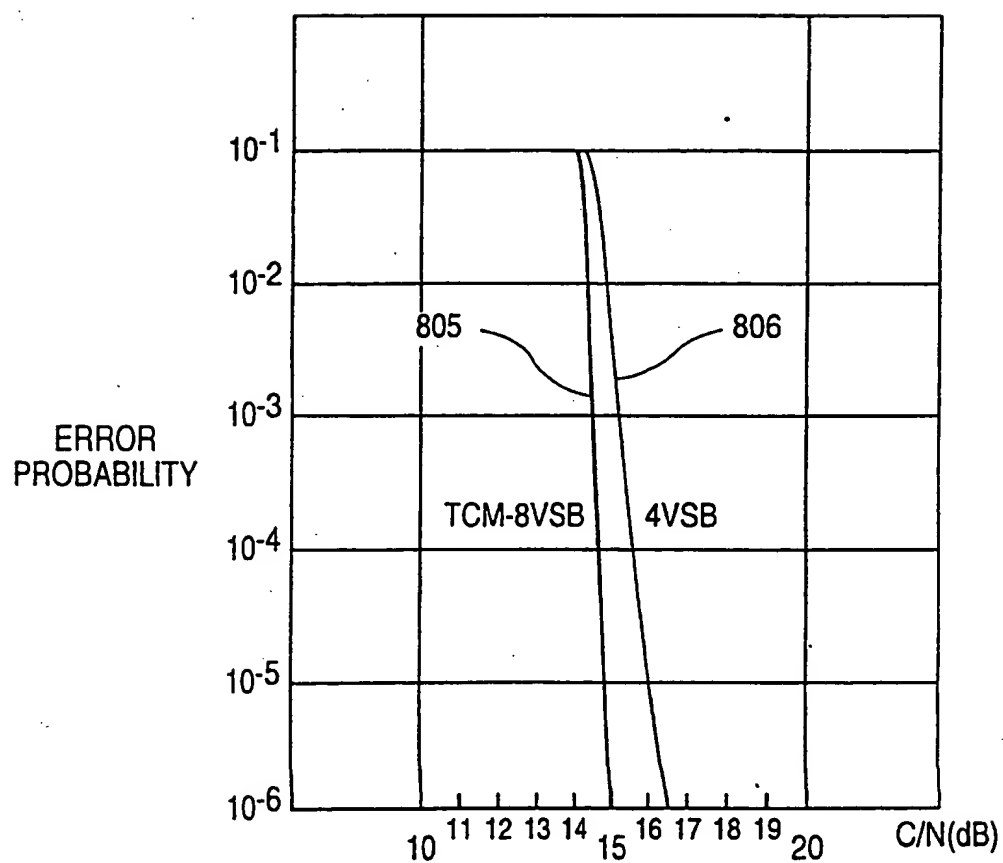


FIG. 164

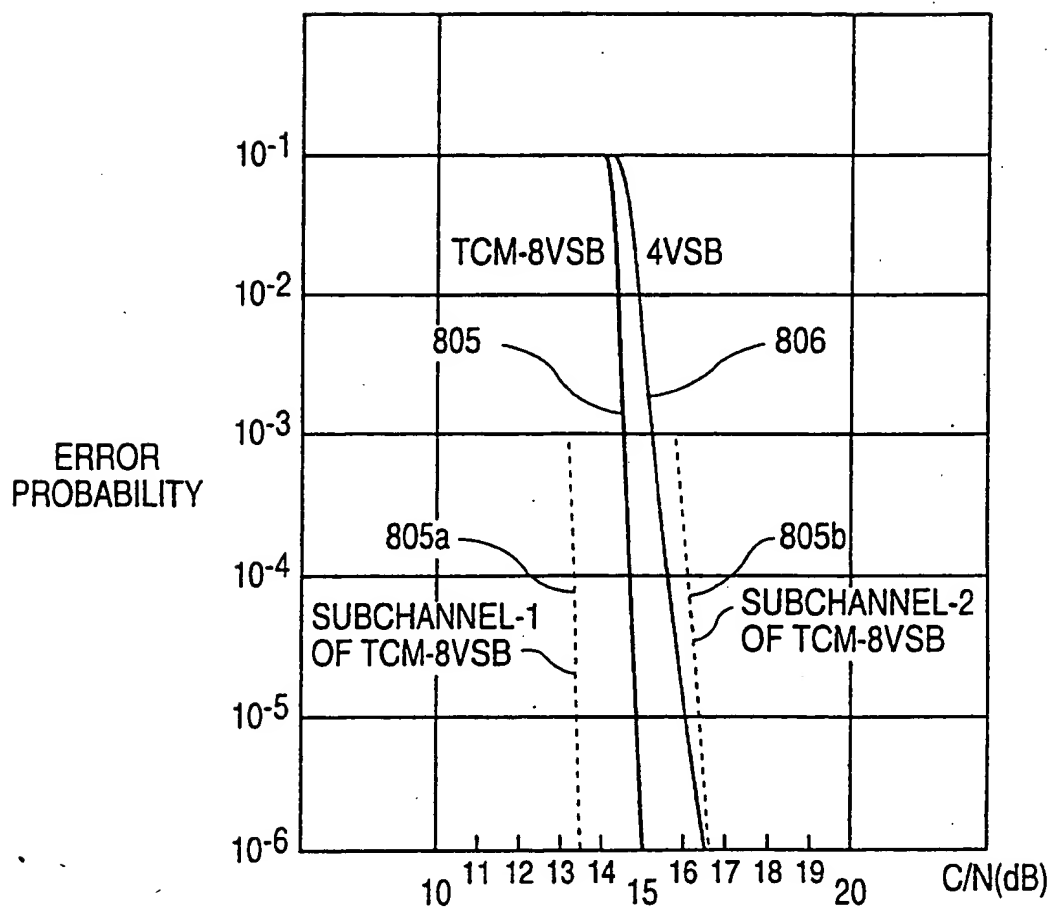


FIG. 165(a)

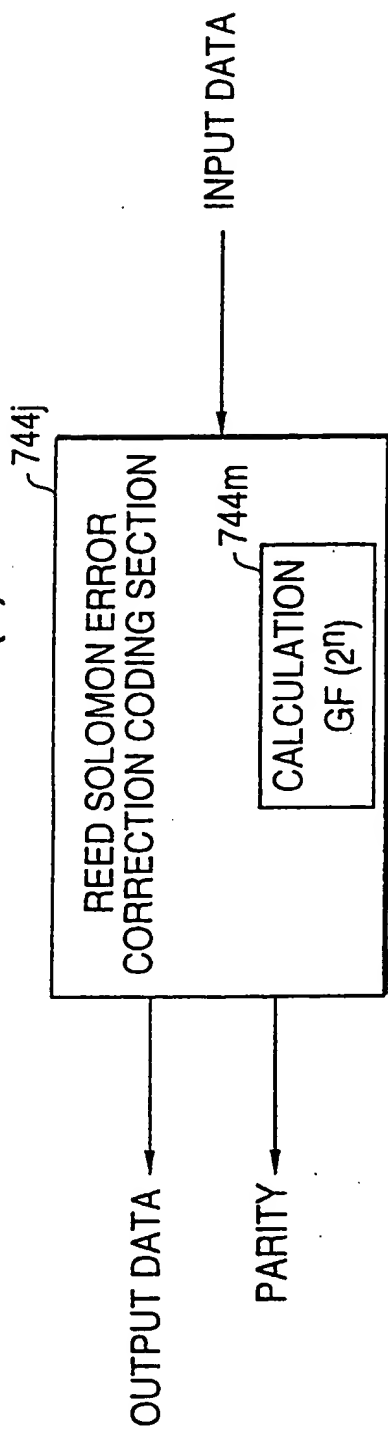


FIG. 165(b)

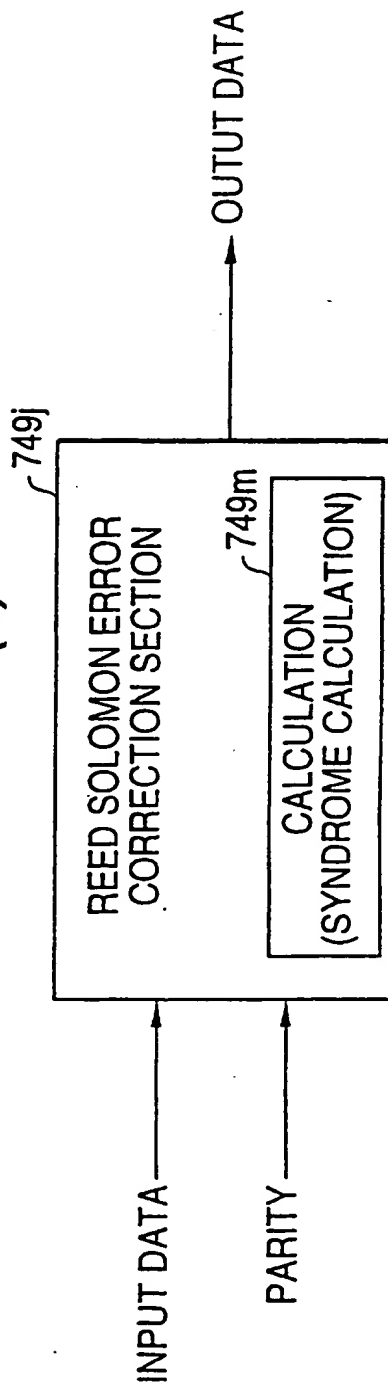


FIG. 166

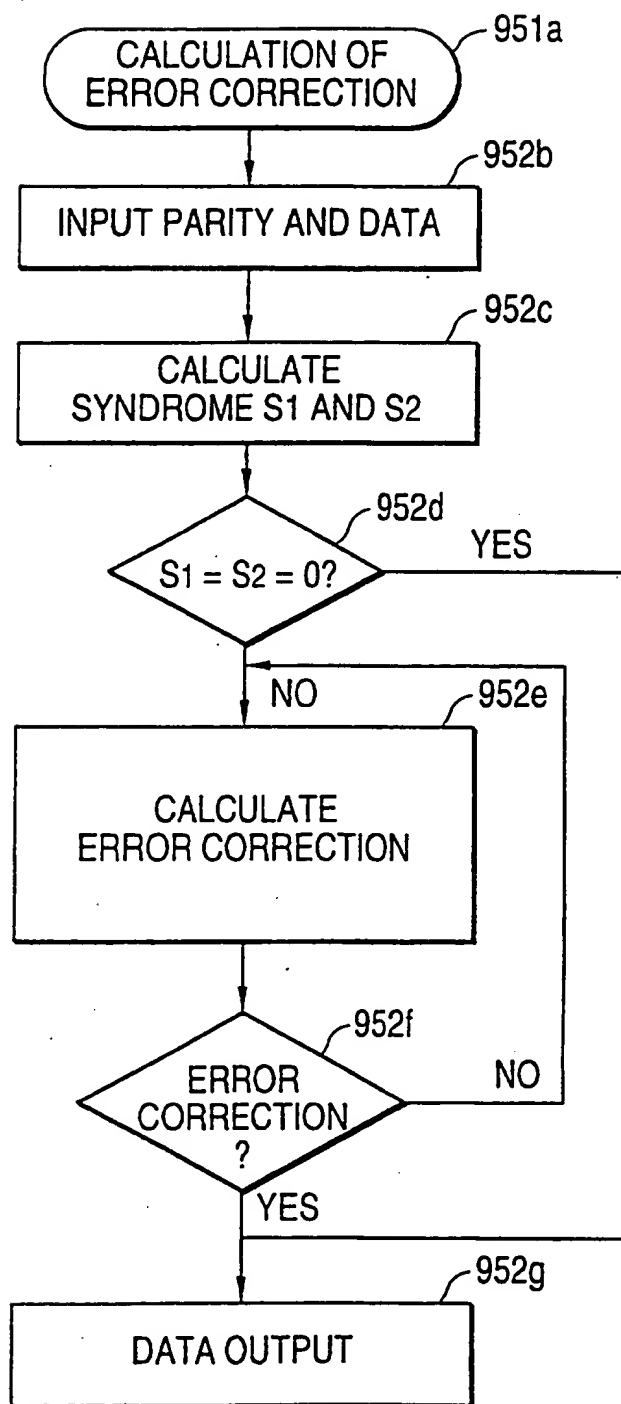


FIG. 167

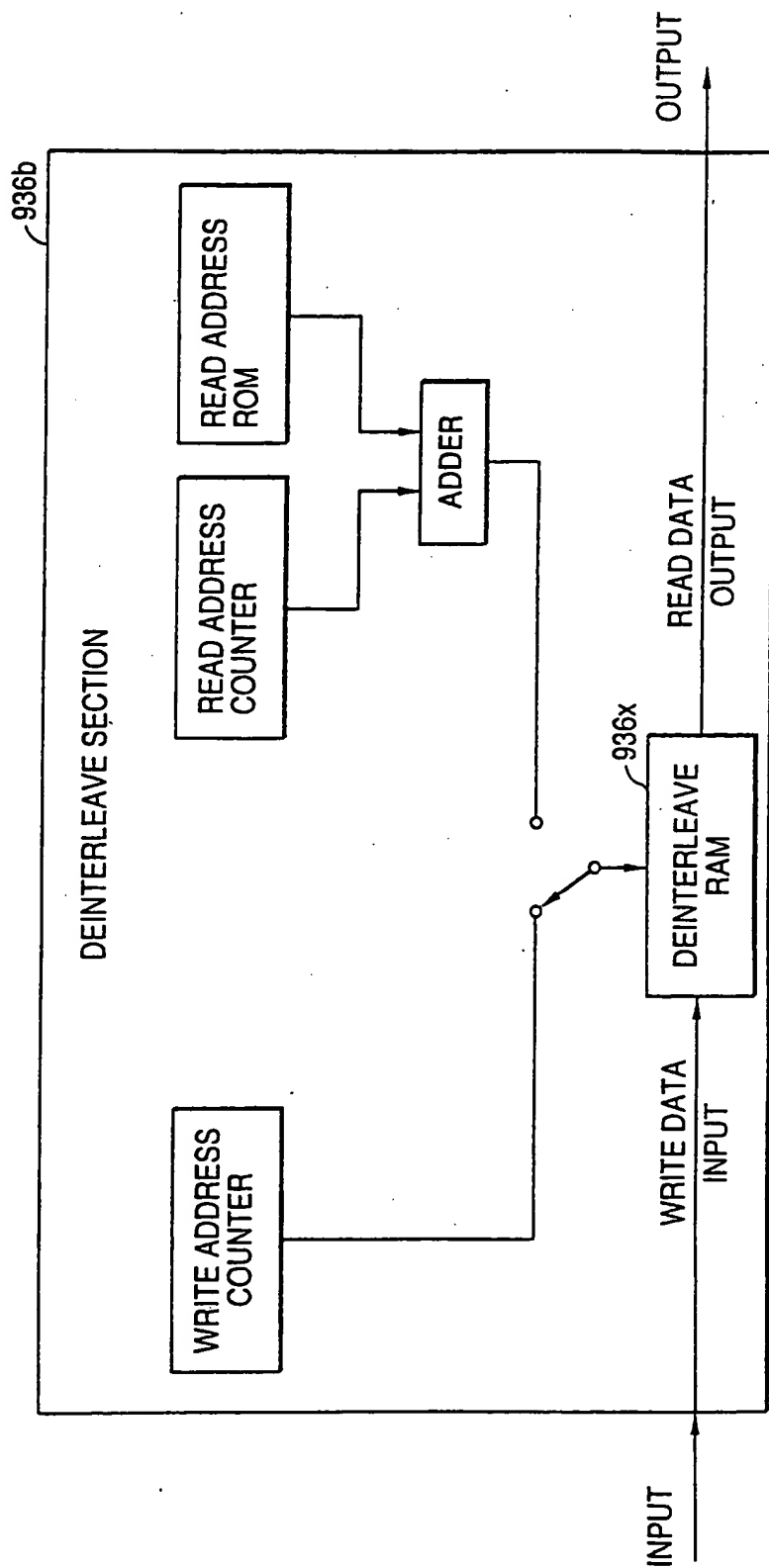


FIG. 168(a)

INTERLEAVE TABLE

1	2	3	4	5	6	7
DATA						C2 PARITY
1	A 1	A 2	A 3	A 4	A 5	A 6
2	B 1	B 2	B 3	B 4		
3	C 1					
4	D 1					
5	E 1					
6	F 1					
C1 PARITY	PARITY	PARITY	PARITY	PARITY	PARITY	PARITY

FIG. 168(b)

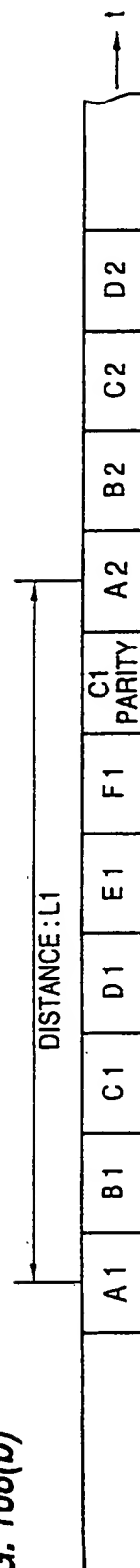


FIG. 169

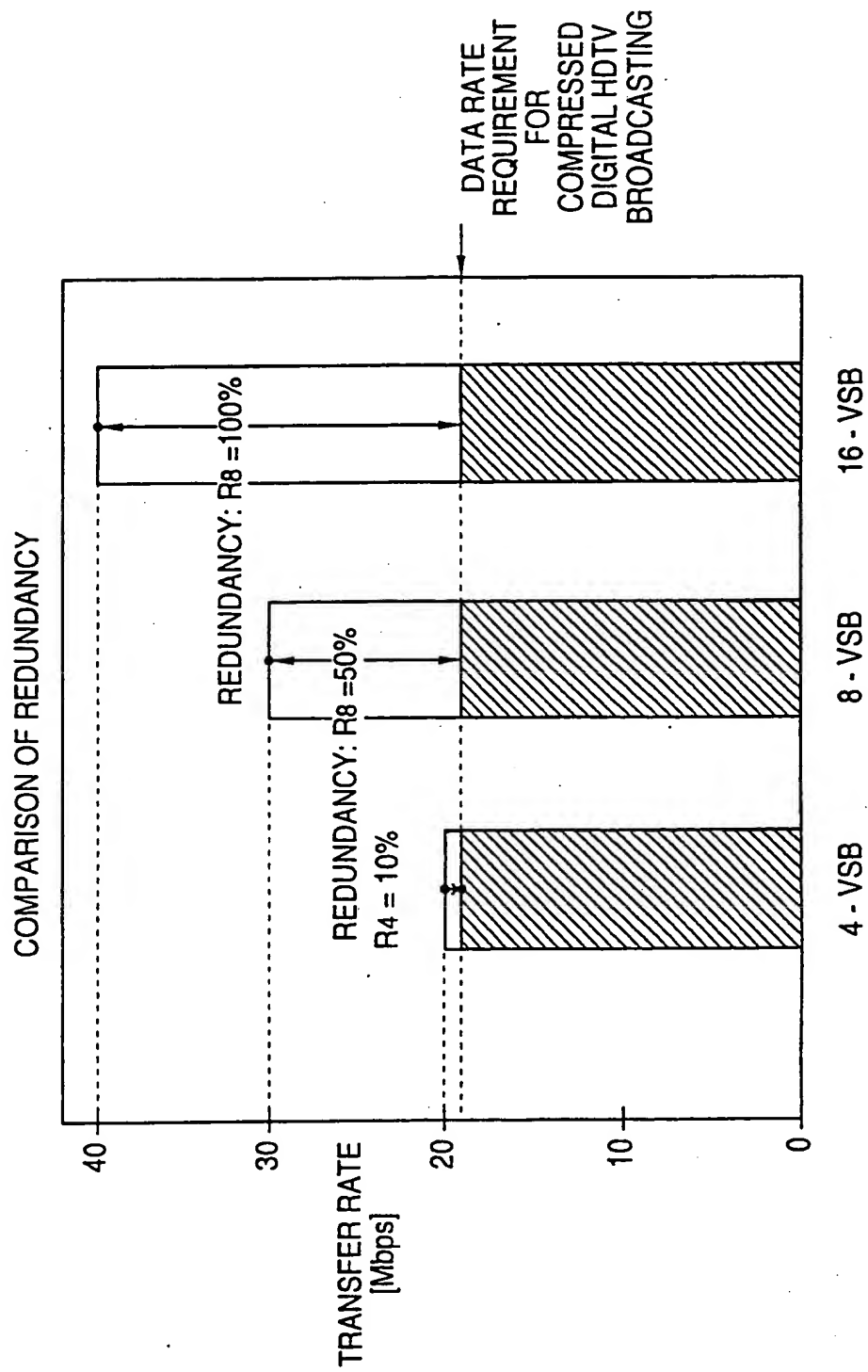


FIG. 170

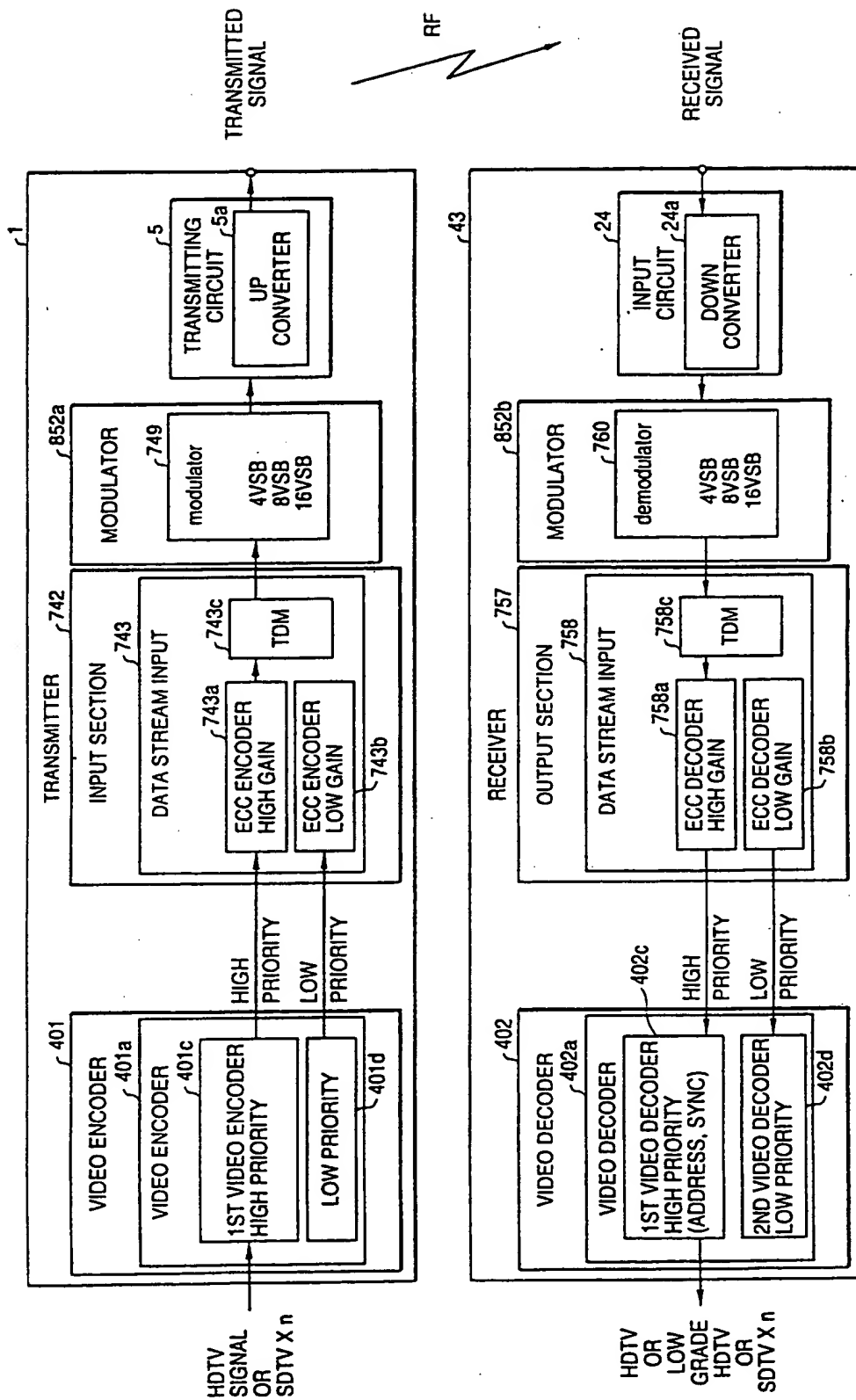


FIG. 171

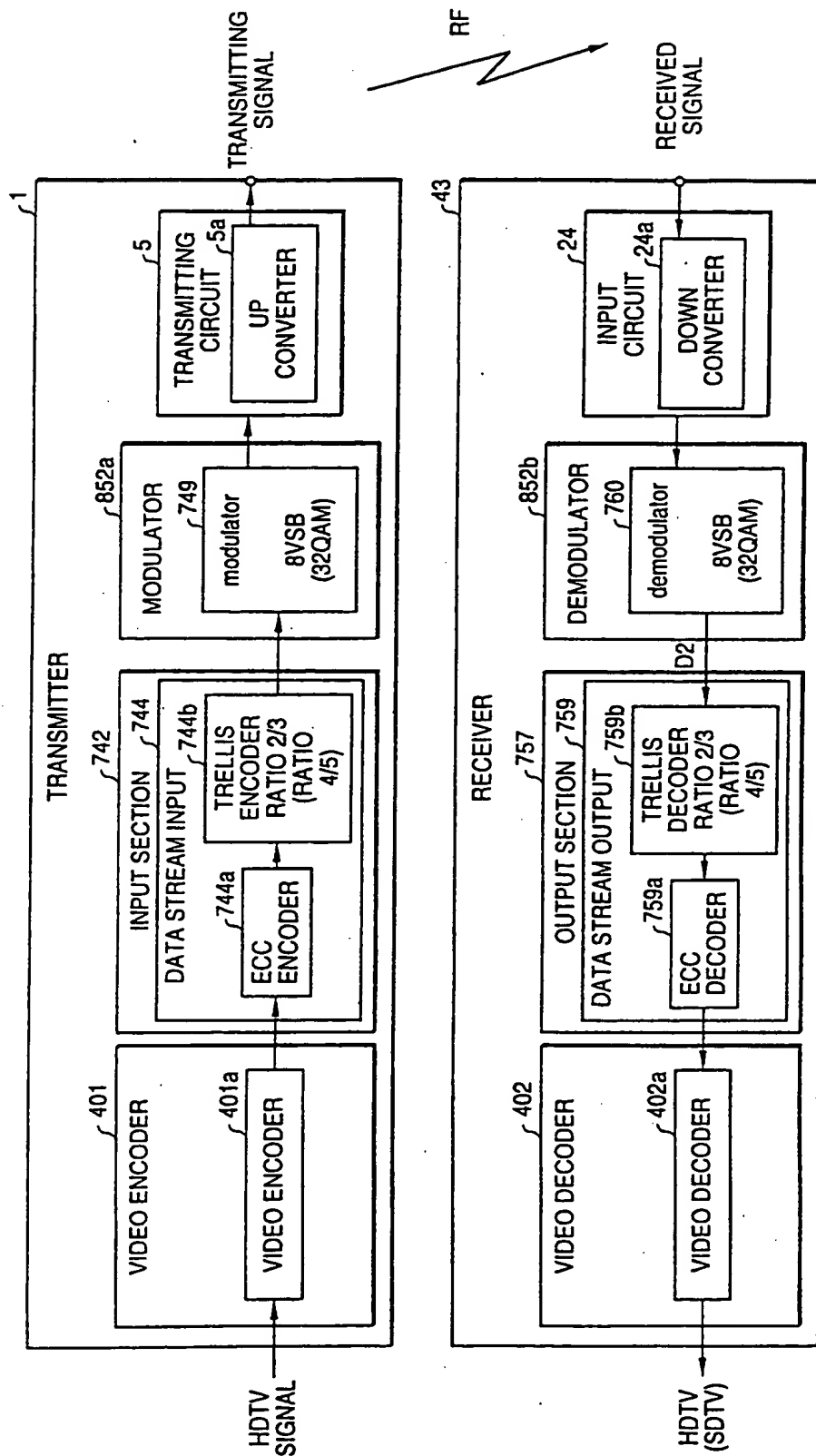
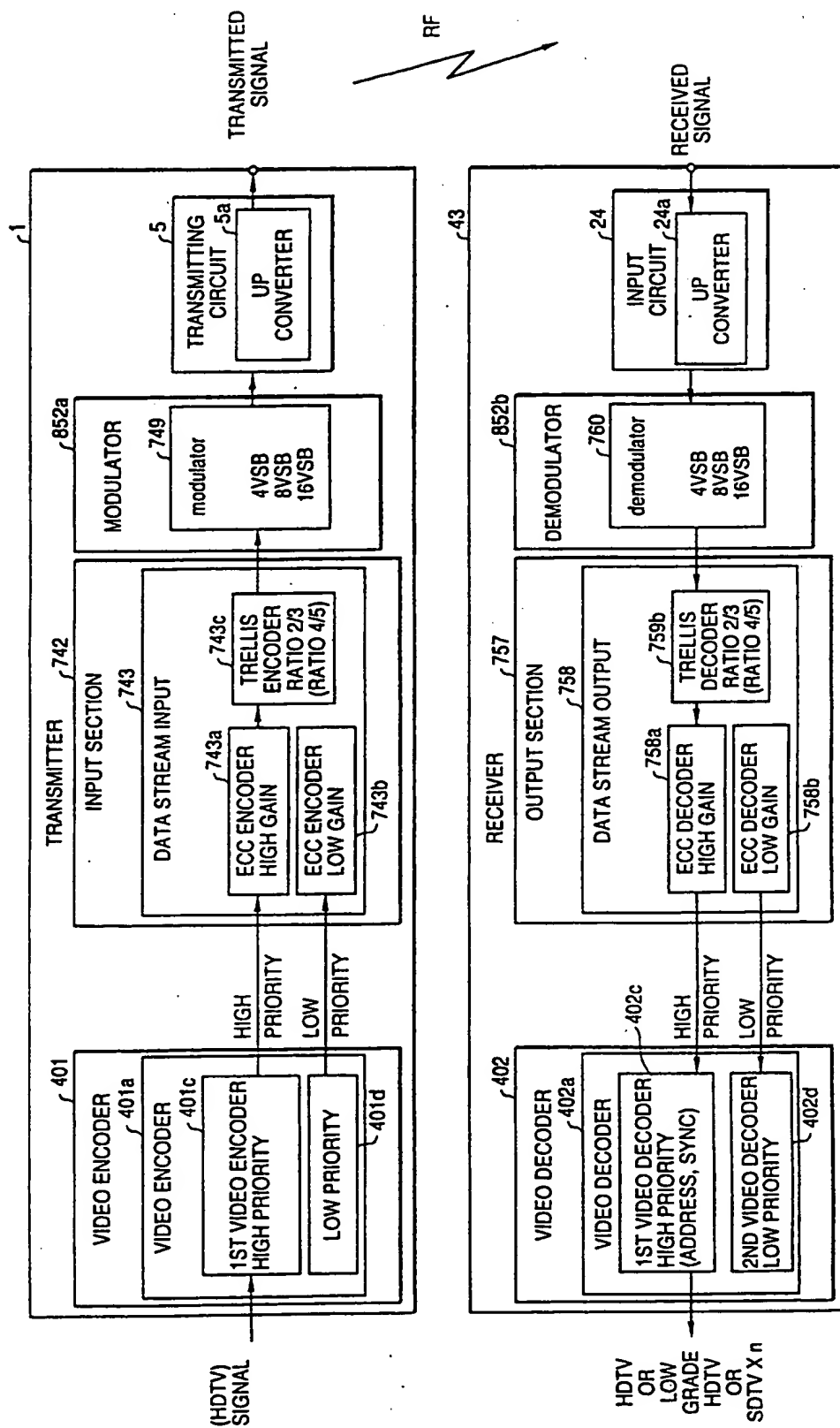


FIG. 172



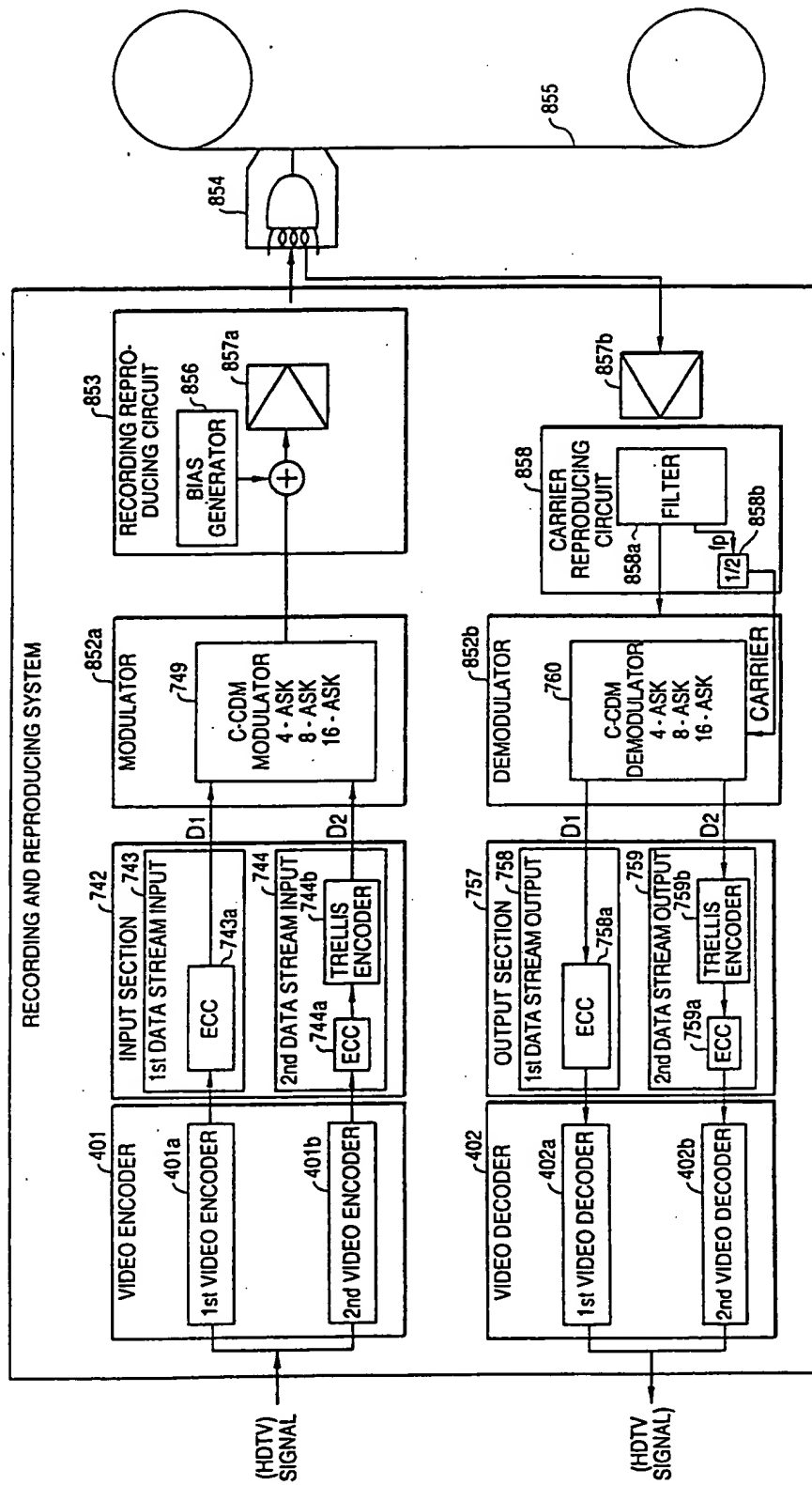


FIG. 174

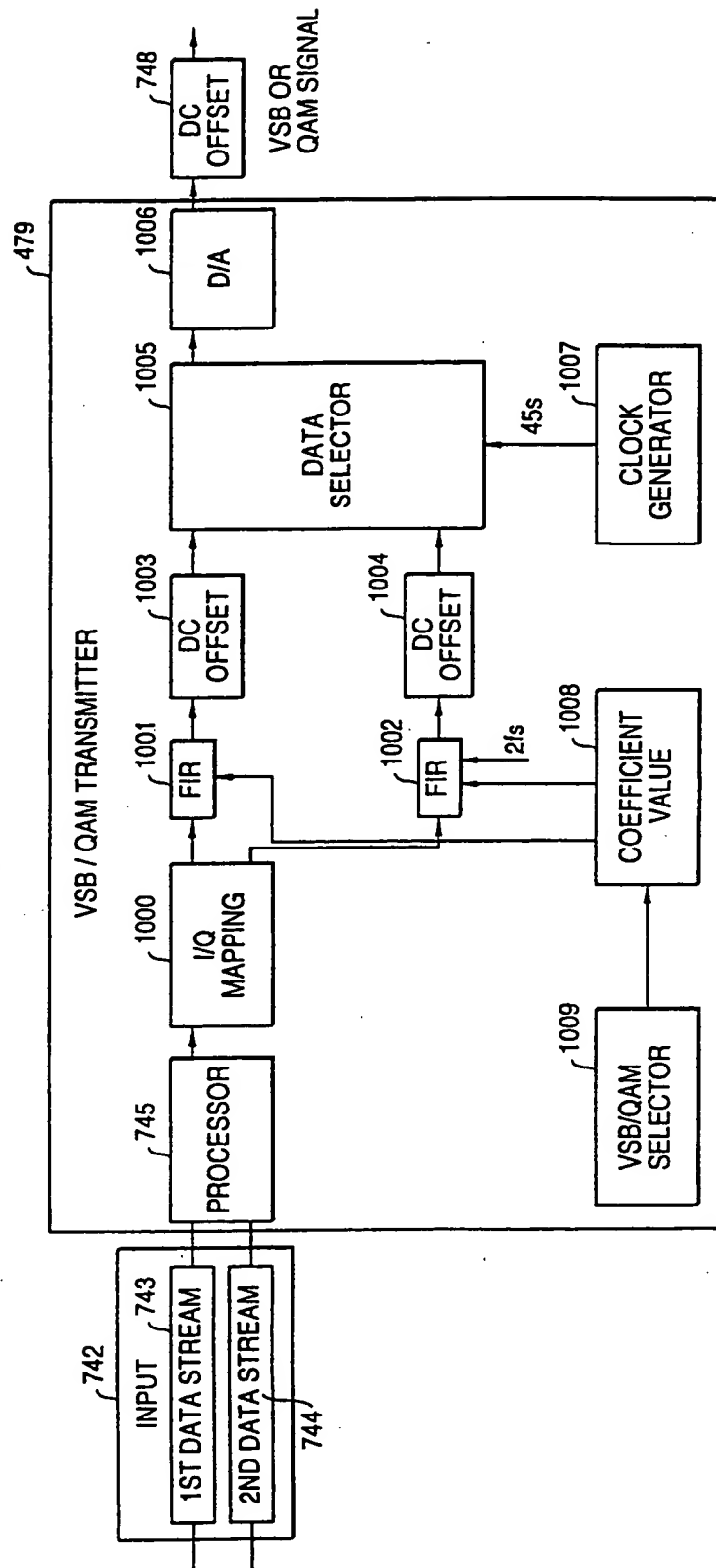


FIG. 175

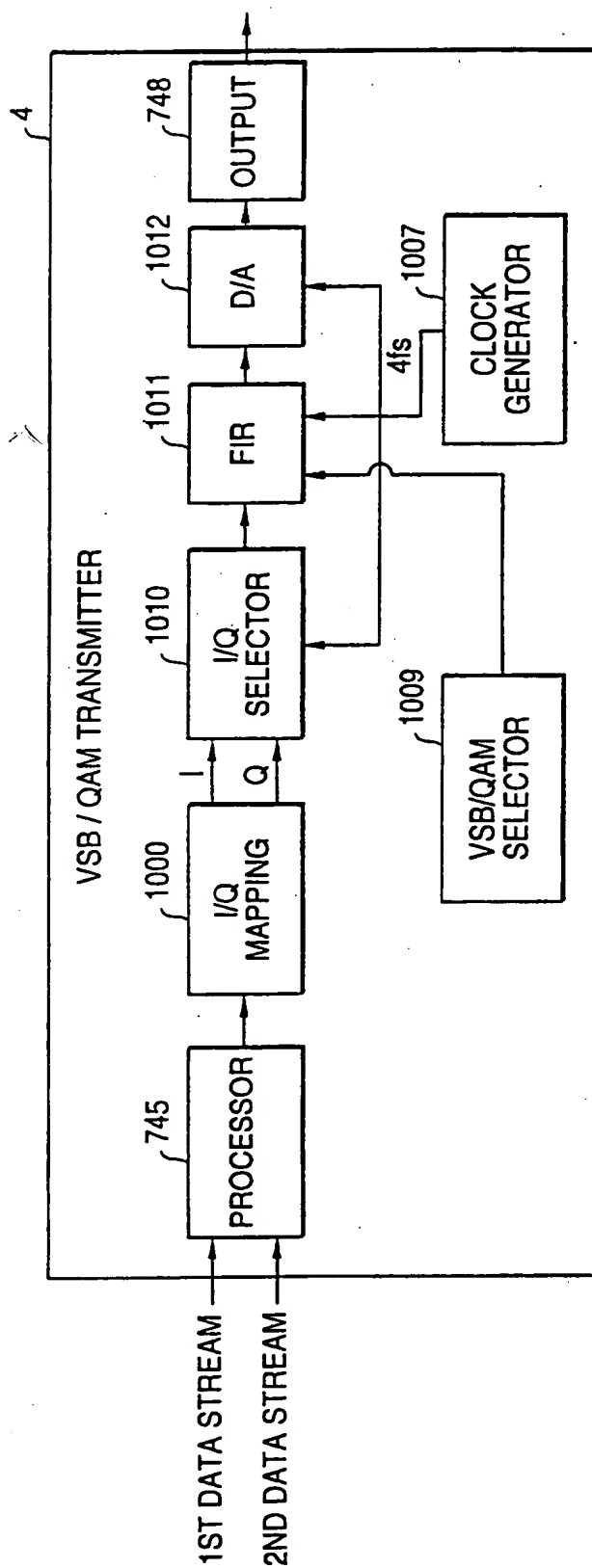


FIG. 176

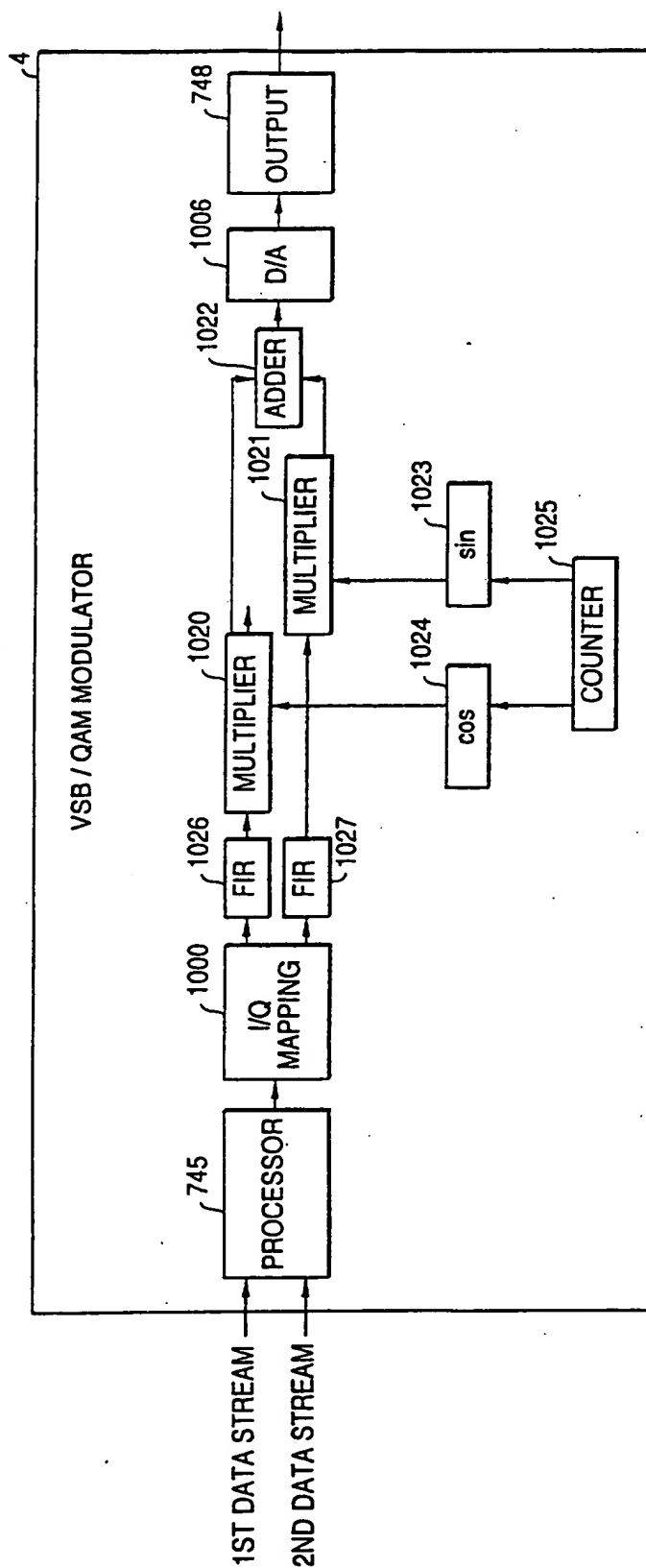


FIG. 177

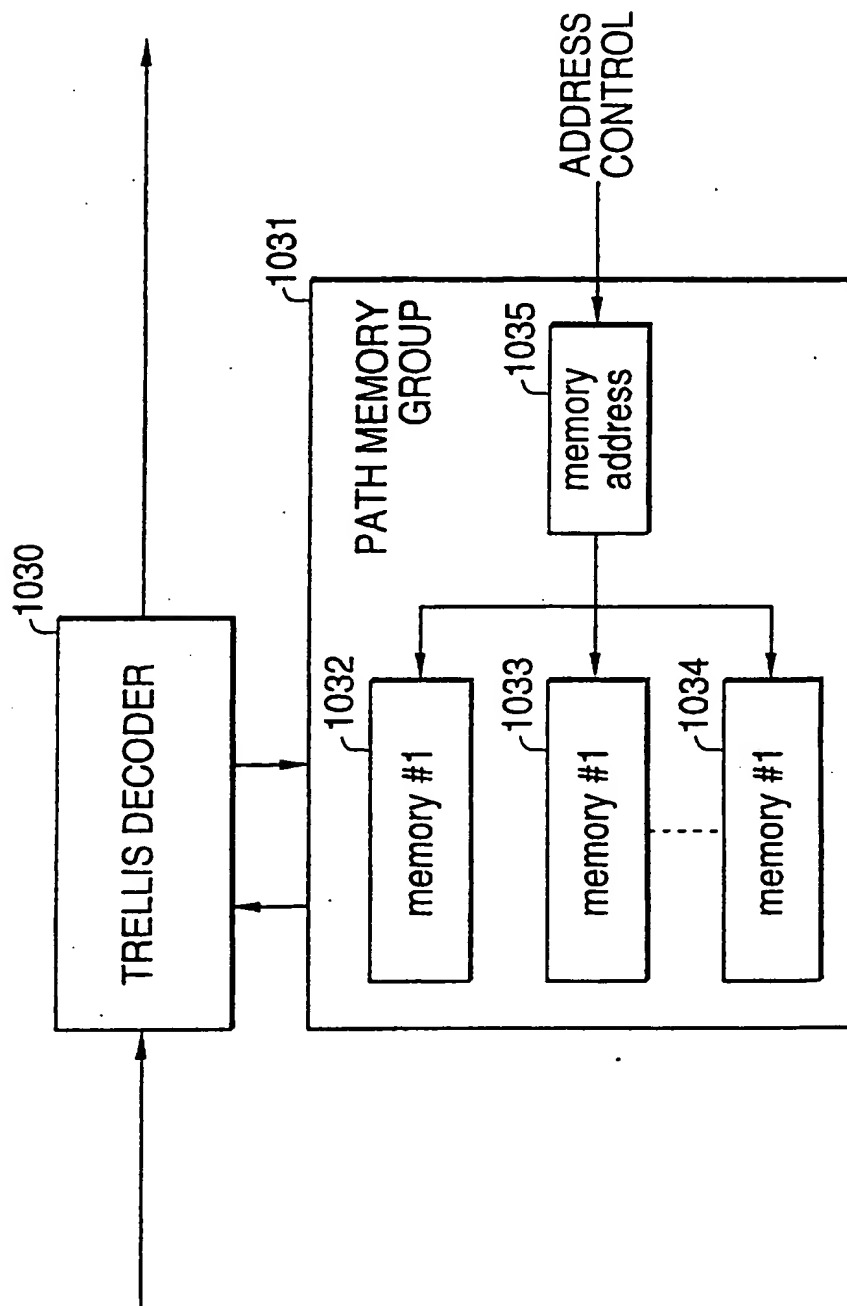


FIG. 178

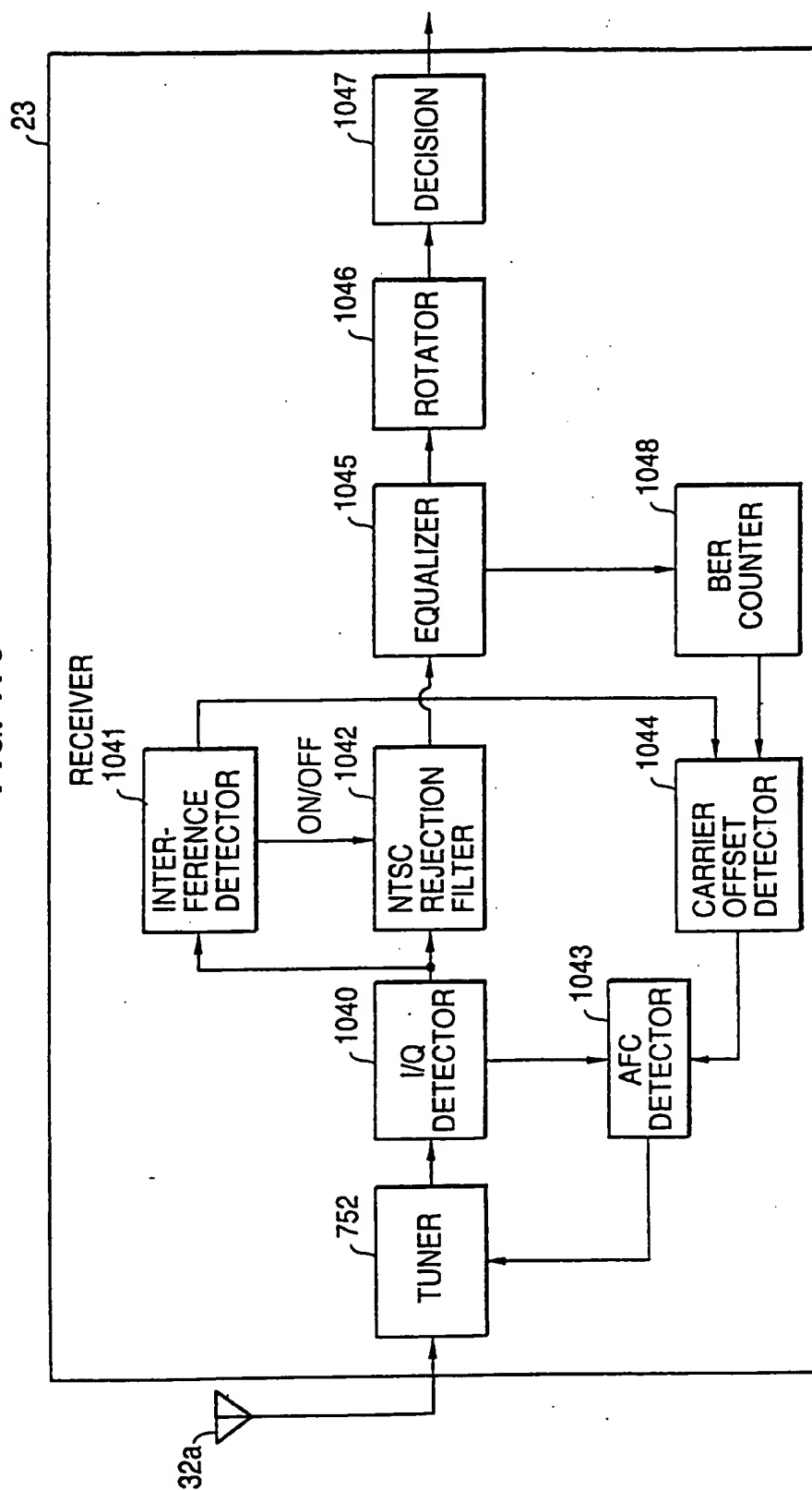


FIG. 179

